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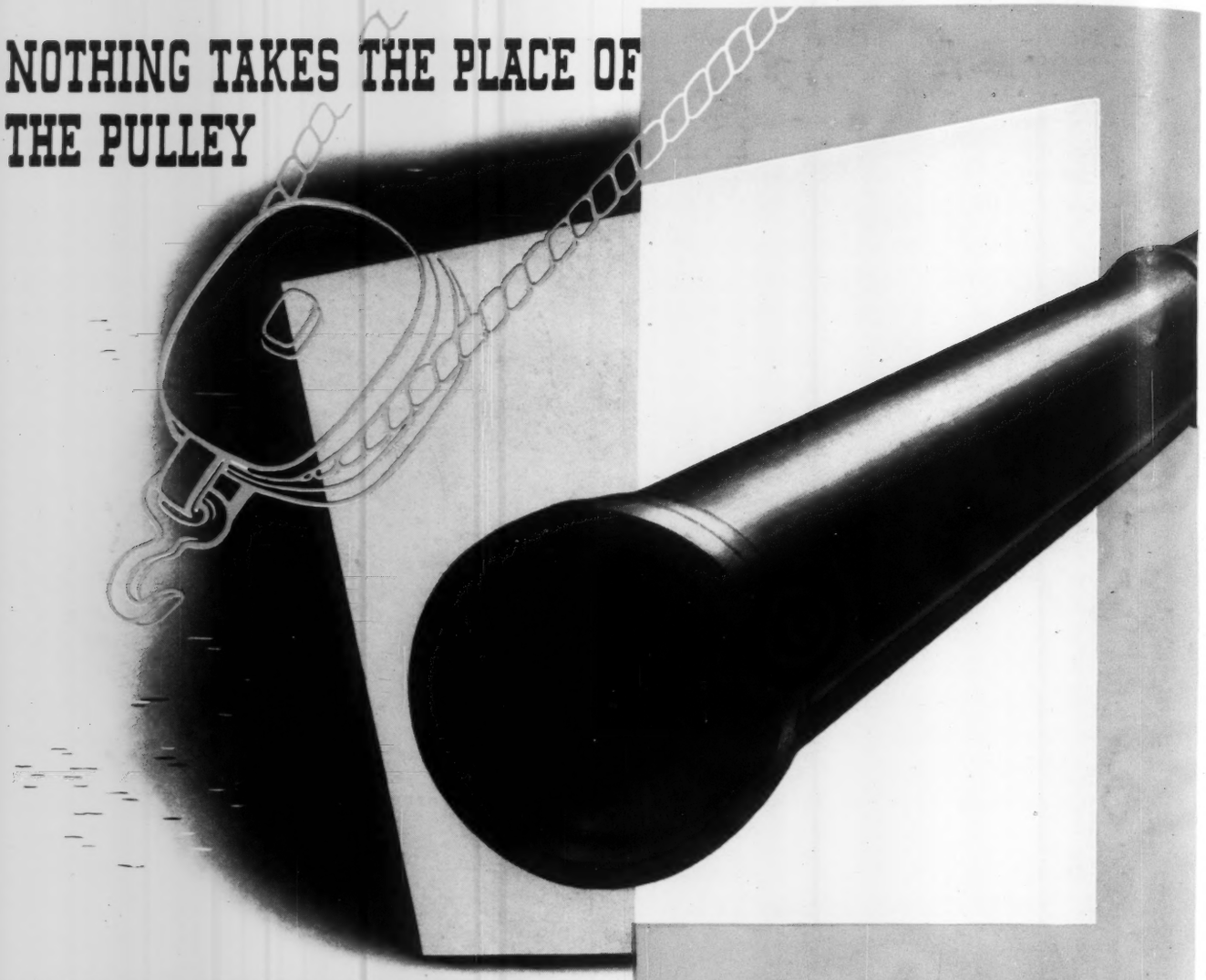
MANUFACTURING PRECAST CONCRETE PIPE FOR THE DELIVERY LINES OF THE COLORADO RIVER AQUEDUCT SYSTEM

Volume 8 — Number 7

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

JULY 1938

NOTHING TAKES THE PLACE OF THE PULLEY



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VOLUME 8 NUMBER 7

July 1938

Entered as second class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

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AMERICAN SOCIETY OF CIVIL ENGINEERS
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CIVIL ENGINEERING

Published Monthly by the

AMERICAN SOCIETY OF CIVIL ENGINEERS
(Founded November 5, 1852)

PUBLICATION OFFICE: 20TH AND NORTHAMPTON STREETS, EASTON, PA.

EDITORIAL AND ADVERTISING DEPARTMENTS:
33 WEST 39TH STREET, NEW YORK

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SUBSCRIPTION RATES

Price, 50 cents a copy; $5.00 a year in advance; $4.00 a year to members and to libraries; and $2.50 a year to members of Student Chapters. Canadian postage 75 cents and foreign postage $1.50 additional.

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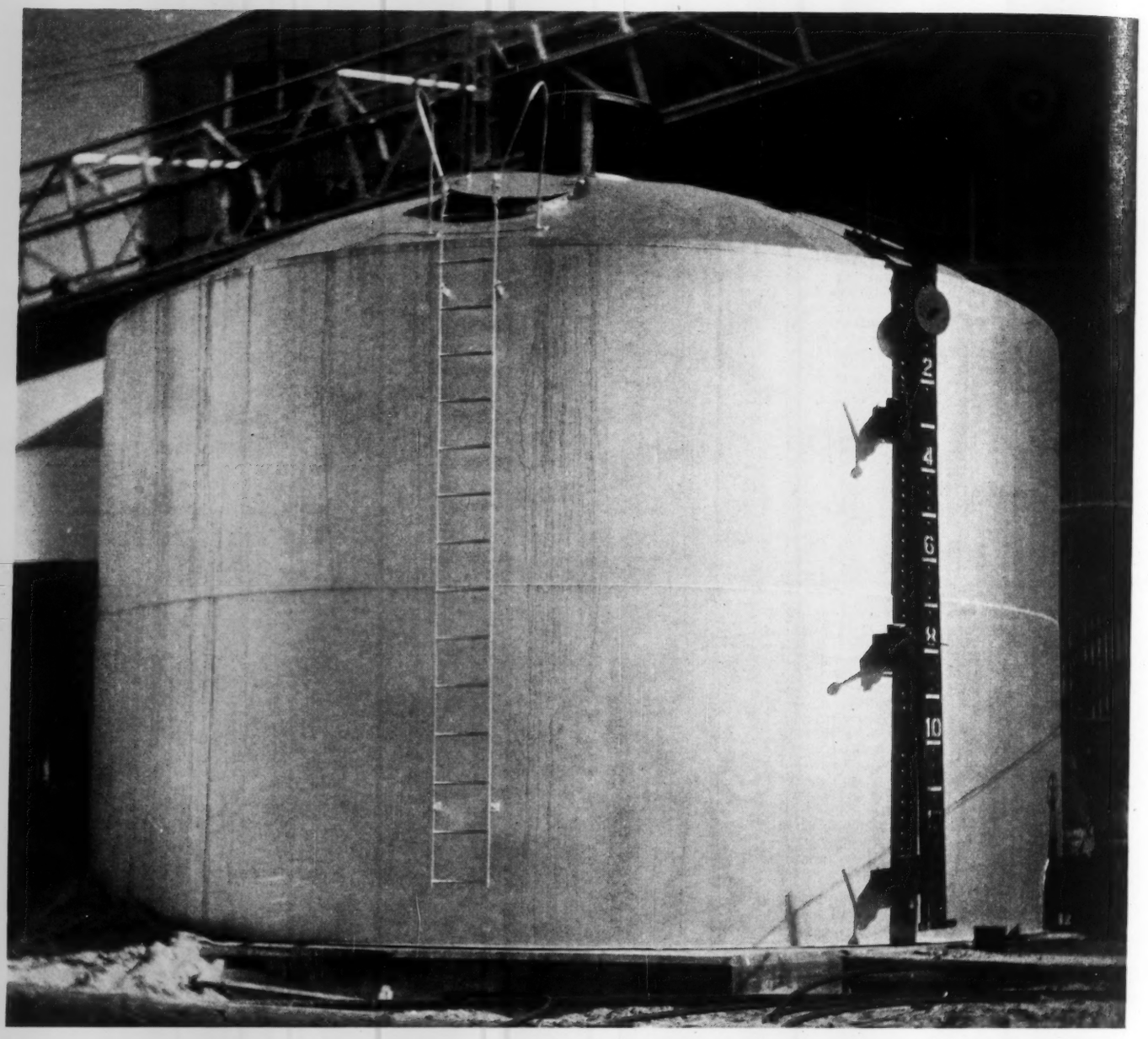

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Bargains in Engineers

Some Effects of the WPA on the Engineering Profession

By SAMUEL M. ELLSWORTH
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, BOSTON, MASS.

WHEN the New Deal adopted its policy of public works construction for the relief of unemployment it was obvious that engineers, particularly civil engineers, would be called upon to play a leading part. The various federal public works organizations that have come into being since 1932 have actually been conducted to a large extent by engineers and architects. At present the most active relief agency is the Works Progress Administration, or WPA. Its functions are broad, but from the standpoint of numbers of men employed and allotments of federal funds, public works construction leads all its activities. It begins to look as if this will continue for some time to come.

Toward Better Engineering on Public Works.~While engineers have received considerable benefit from public works construction carried out during the last five years under the stimulus of federal financial support, it is evident that the profession as a whole has not been utilized to best advantage. Cities and towns have planned and constructed WPA projects which, under normal conditions, would require engineering talent of a high order but which under present conditions receive only casual and inadequate engineering supervision—this despite the fact that there have been thousands of qualified engineers whose services could have been utilized to advantage but who for various reasons have been denied the opportunity of participating.

Originally the WPA was developed to undertake projects which involved low costs for materials and inception on short notice. However well-intentioned those in charge, in the beginning it was subject to local political influence. Since considerable discretion was given to the authorities in Washington regarding the allotment of WPA funds, states, counties, and municipalities used every influence at their disposal to secure special consideration. Many of the so-called "boondoggling" projects of the ERA were continued by the WPA, not so much because the government encouraged them as because cities and towns were either unable or unwilling to spend their own money for proper planning and supervision and for such construction materials as would be required for worth-while public works.

Many of the deficiencies of the early months of the WPA have been eliminated. Projects designed for no other purpose than to keep men at work, regardless of the economic value of the work done, are on the way out. During the years when major works were being financed through, and supervised by, the Public Works Administration (PWA) it was intended that the WPA should limit its construction activities to public works estimated to cost not more than $25,000. At present there is practically no cost limitation on WPA projects, providing they meet certain general requirements—for example, a subway extension in Boston, to cost several millions, was formerly not eligible for a WPA grant.

Salaries Are Debased.~Other changes more important to the engineer have also been taking place. On certain planning projects, set up to prepare work-relief programs, the salaries of some engineers, not eligible for relief, could be paid from federal funds. This was permitted because many cities and towns were not awake to the advantages of planning work-relief programs or were unable to secure local appropriations for such planning. Had this not been so, these programs would have bogged down completely. It is my observation that the use of engineers, outside of the staff of the WPA, and not eligible for relief, has been gradually discontinued.

Unfortunately, many communities have been reluctant to appropriate money for competent engineering services and are attempting to plan public works projects with men on relief, many of whom are not qualified as engineers. Such a situation is not only demoralizing to those engineers who are on relief but is also disastrous to qualified engineers who are doing their best to keep off the relief rolls.

Many planning and research projects approved by the WPA are now in operation. Some are functioning reasonably well; others are of little or no value because qualified men were not available on the relief rolls to plan and execute them. Supervision is generally supposed to be furnished by the agency that sponsors the projects. While it may agree to appropriate the necessary funds, the project frequently receives only such supervision as the sponsor's own engineering forces are able to spare from their regular duties.

Even Worthy Projects Disappoint.~A most discouraging outlook faces those projects that are being operated efficiently and producing valuable and essential engineering or scientific data. One such project, the Massachusetts Geodetic Survey, is using WPA engineers and surveyors to establish from the U. S. Coast and Geodetic Survey network, the position of intermediate

points throughout the state, meeting all the standards of the Survey. After nearly five years this "emergency" work relief project is still in operation. The average federal allotment for salaries cannot exceed $1,140 per man per year, and it is now proposed to reduce this to less than $1,000. Here are some 400 conscientious, well-trained men, many of them engineering graduates, who are performing work that would normally carry at least double the present "subsistence" wage. A project started with the best intentions has become a boomerang to the engineering profession and such a bargain to the state which sponsored it, that it promises to become a permanent institution.

While engineers may not be entitled to greater consideration than other groups of relief workers, it is unfortunate that where efficient conduct of a work relief program depends so much upon adequate engineering planning and supervision some means should not be developed whereby engineers could be employed before their financial position had been so reduced that they must seek relief. The WPA is chiefly a clearing house for work relief projects and is primarily concerned with certification, employment, and payment of WPA workers. As a general rule the responsibility for the engineering design and supervision, and the blame if defective, rest with the sponsoring agency. Examples of poor design and construction of WPA works are not hard to find.

Ill Effects on Construction and Engineers.—While the WPA has been a blessing to thousands of engineers, particularly those in the subprofessional grades, it has done untold injury to the construction industry. Many first-rate public works contractors have gone out of business. Furthermore, with the predominant use of hand labor on WPA projects there is little opportunity for using construction machinery, and manufacturers have naturally suffered. Private engineering organizations have also been adversely affected, in spite of the fact that there should be at least as much demand for their services under present conditions as in normal times.

One effect on the engineering profession of thus disrupting long-established procedures has been to lower general standards of engineering by placing undue emphasis on its cost. In so doing the fact is overlooked that professional engineering is more than preparing plans and giving lines and grades; that economics—a balancing of construction, operation, and maintenance costs by the benefits to be derived—is all-important.

Even worse, the effect on the individual engineer is demoralizing. With the possible exception of those employed in permanent civil service positions, public works construction under the WPA appears to be reducing the engineer not already on relief to a point where he will be compelled either to seek a place on the relief rolls or to give up his profession. Opportunities that would normally be open to recent engineering graduates are now being filled by WPA relief engineers who, even in supervisory positions, receive little more than a living wage. Worse still, there are virtually no prospects for advancement. Rarely is there an opportunity for them to receive the usual benefits of training for more responsible positions. Where there is no requirement that a construction project be completed before a given date, or no penalty if a federal allotment of funds is exhausted before the completion of the project, there is little incentive for efficiency. The more intelligent and ambitious engineers on the WPA projects realize the hopeless situation that confronts them. If they aspire to joining private organizations, every day they continue with the WPA raises the bars a little higher against attaining their aspirations. Unwillingly, and because of circumstances apparently beyond their control, they find themselves working against their own ambitions, removing the possibility of attainment farther and farther away.

But Remedy Is Possible.—Assuming that the WPA is to be with us for some time to come, what can be done to protect the civil engineering profession from the demoralizing influences that are threatening it? Obviously if the WPA policy-makers in Washington saw fit to take action in this matter, remedial measures could be put into effect in a relatively short time. Let the WPA set up reasonable standards of engineering procedure for cities to follow in the planning, designing, and supervision of construction of its projects and insist that such standards be followed, and it would not be many weeks before competent engineers now on the relief rolls would find other employment either in municipal, county, or state engineering departments or in the offices of established engineering concerns. As a second step, let the WPA take a less lenient policy regarding the granting of supplemental funds for projects that cannot be completed within the original allotments.

In the case of planning and survey projects on which the majority of those employed are supposed to be engineers or technicians, the WPA should insist that only men qualified by education and experience be employed even though it becomes necessary to require applicants to submit to competitive examinations. If qualified engineers are not available for these projects, money should not be allotted to them simply to give employment regardless of the fitness of those employed. As a further condition, let the WPA require that the sponsoring agency contribute at least as much money as is allotted by the federal government and let the combined funds be used to raise the monthly income of the engineers employed to a level more consistent with prevailing salaries in the regular civil service.

Engineers, Awake!—Apparently the WPA has been working towards these objectives, but in spite of any temporary embarrassment to cities and towns and other sponsoring agencies, it would be to the best interests of all concerned, including the engineering profession and every self-respecting WPA worker, to cease temporizing in this matter. While the WPA is in a strategic position to expedite reforms in work relief policies and procedures, the engineering profession must make more of an effort to save itself. The profession has an obligation not only to its members but to the country as a whole and should take active and vigorous steps to stimulate the adoption of needed reforms.

Unless the profession awakens to a realization of its reponsibilities, it faces a continued lowering of its social and economic status. The engineer is one of the foundation stones of our present social structure. If he now fails to exert his influence in his own behalf not only will it be disastrous to himself, but the stability of the entire structure will be threatened.

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CIVIL ENGINEERING

JULY 1938

VOLUME 8 NUMBER 7

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Towards Better Low-Cost Roads

A Review of Current Practice in Soil Testing and Soil Stabilization in the Southeastern States

PUBLIC demand for low-cost, all-weather roads has caused the highway engineer in recent years to give constantly increasing attention to the use of the most abundant and cheapest material available—the soil. Throughout the United States the soil-testing programs of the various highway departments have expanded, and concurrently a variety of more or less satisfactory soil stabilization methods have been developed.

In the accompanying articles, attention is focused on work in the southeastern states: Mr. Mills draws from his experience with the laboratory of the South Carolina Highway Department to discuss various points in the technique of testing; and Mr. Weathers describes the stabilization methods in use in various parts of the Southeast, emphasizing particularly the soil-cement method and the sand bituminous road mix. Both articles are abridgments of papers that were on the program of the Highway Division at the Society's 1938 Spring Meeting, in Jacksonville, Fla.

Sampling and Testing Soils

By W. H. MILLS, JR.
TESTING ENGINEER, STATE HIGHWAY DEPARTMENT, COLUMBIA, S.C.

IT was not over twelve years ago that the first sample of soil was brought to the South Carolina Highway Department laboratory for testing. Since that time the soil-testing program has developed rapidly, and at present it constitutes one of the principal functions of the laboratory. Investigations are made of soils to be used as bases for bituminous surface treatment, as subgrades for rigid pavements, as bridge foundations, and as fill materials. It is the purpose of this article to discuss a number of important points in the technique that has been developed.

IMPORTANCE OF SAMPLING

In studying soils for any project, the selection of samples is the most important and the most difficult part of the investigation. No matter how carefully tests are performed, the results are of no value unless the samples truly represent the soil that will be used in the finished work. All test methods state that the samples should be "representative," but this statement, while sufficient if clearly understood, does not give adequate emphasis to the importance of this part of the work. We find it very difficult to train a laboratory man, even with his background of care and precision, for sampling work; and many field men do not realize the importance of minute care in obtaining the whole sample, or understand how to split a large sample in order to secure a representative portion. If the average condition is desired, it is very important that all the material from a small test hole be saved, mixed, and reduced by "quartering" to the size required; but occasional grab samples give better information on the variations encountered. Large field samples should always be placed on a piece of tin, canvas, or similar material where all portions can be thoroughly mixed. In sampling soils in the roadway it is very easy to include an excess of the material near the top, as the sample hole is usually shallow and larger near the surface.

Even after a sample is brought to the laboratory, the operator must be extremely careful in splitting it into smaller portions for tests. The principle of "quartering" is generally understood, but many operators forget that unless the material is thoroughly mixed, after each reduction, then flattened, and carefully divided into quarters, the final sample is likely to be "off."

Methods for making soil surveys are given in the specifications of both the American Association of State Highway Officials and the American Society for Testing Materials. These methods are certainly adequate but probably are more expensive than average conditions encountered by the highway engineer would justify. Soil surveys made before bids are received on a project, will, however, more than pay for themselves in better classification of excavation, better planning of drainage structures, more accurate determination of overhaul, better selection of fill material, and accurate location of pits for selected soils. The soil survey need not be elaborate but it must be made by an experienced engineer who knows what to look for and how variations occur. For instance, a man familiar with the way in which sand-clay soil or top-soil occurs can find these materials in areas where an inexperienced man would report that none was available.

ROUTINE TESTS

Methods for testing soils are available in the standards published by both the American Association of State Housing Officials and the American Society for Testing

Materials. The mechanical analysis is probably the most important of these tests. Years ago C. M. Strahan, M. Am. Soc. C.E., of the University of Georgia, developed an elutriation test for separating the fines in soils. Clay and silt, as determined by his method, include somewhat larger particles than in the Bouyucos hydrometer method, but the Strahan method gives essentially the same information and does not require as expensive equipment. It is quite satisfactory as a field test, and is used extensively in the southeastern states. For control, a determination of the total passing the No. 200 sieve by washing is very effective when used in conjunction with a sufficient number of accurate determinations of the silt and clay content. These tests are based on the rate of settlement of spherical particles through a liquid, and the portion defined as clay may or may not be true clay according to the geologist. The tests do not consider the shape of the particles, and as we know that shape is one of the fundamental differences between silt and clay, the grading tests must be supplemented by other tests which measure the properties of the clay.

In addition to the mechanical analysis, we determine the liquid limit, plasticity index, and shrinkage limit on all samples from pits. These tests appear to give sufficient information on soils as materials for bases, but tests for "swell" and the percentage of mica would be of considerable value in some soils. Mica is very objectionable in most soils for highways but the determination of the quantity of this substance is so expensive that it is prohibitive as a routine laboratory test.

Methods for performing tests have been well standardized, but experience is of great importance in interpreting test results. Specification limits should always be based on results from materials that have proved satisfactory. For instance, a soil having a plasticity index of 6 or less is generally satisfactory as a base for bituminous surfacing, but a soil with an index of 12 or 18 may be all right in certain localities where subgrade, rainfall, or water-table conditions are favorable. The best way to develop satisfactory specifications is to test samples of soils that are satisfactory in service and use the results as a guide.

COMPACTING SOILS

Adequate consolidation of soils in fills or bases has always been a great problem, and in our opinion the Proctor principle of compacting soils is the greatest single contribution to its solution to become generally used in the last five years. Proctor's work was explained in the *Engineering News-Record* for August 31 and September 7, 21, and 28, 1933. The principle is based on the direct relation that exists between the moisture content of a soil and the density to which it can be compacted. The moisture content at which maximum density is obtained is defined as the optimum moisture content for compaction.

The laboratory method developed by Proctor for determining the optimum moisture content is in general use, but there is the distinct possibility that it should be modified for different soils. It is well-known that the application of more compacting force will decrease the optimum moisture content and give greater density than the standard method. Further correlation of the laboratory test with field results is needed. The present test will give for some soils high in clay an optimum moisture content so great that the soil particles will be lubricated and the soil during and after compaction will "give" and "shove" slightly. This is not, in our opinion, the condition for maximum stability. It may be satisfactory for fills and dams, but for stabilized bases it sometimes results in cracking during the final rolling. The present method also is subject to many variations by the operator, and some of these could be removed by the use of simple mechanically operated equipment.

Proctor's method was developed in an arid region, whereas in South Carolina the soils in the borrow pits or roadway cuts frequently contain more than the optimum amount of moisture as determined by the present method. This has happened so often that strict enforcement of the Proctor method would have caused a prohibitive increase in the cost of grading operations. Therefore our specifications have been revised so that there is a wide tolerance in the permissible moisture content for compaction. In spite of this variation, we obtain more stable fills in clay soils by this method than by jetting or other kinds of compaction. The question of "swell" of soils after compaction at optimum moisture content is one that deserves more attention. Some soils high in mica appear to increase in volume after being compacted.

The Proctor principle of soil compaction was designed for soils possessing cohesion, and it does not work very well in cohesionless soils or mixtures of cohesionless soils with bituminous materials. German engineers have published some data on their experiments with different types of vibrating equipment for compacting cohesionless soils, and their method gives promise of wide application in sandy soils or others lacking cohesive properties.

SOIL STABILIZATION

Stabilization is probably receiving more intensive study at this time than any other problem connected with soils. It offers a possibility for further decreasing the cost of low-cost roads, for building low-cost roads in areas where soil conditions are unfavorable, and for preventing failures in high-type pavements by treatment of the subgrade. One of the obstacles to rational design of stabilized roads is the lack of suitable tests to determine the adequacy of the stabilization. Each producer of a material for soil stabilization has developed a different method for determining the quantity of stabilizer needed, and this has resulted in confusion. There may be certain conditions which make it imperative that a particular type of stabilizer be subjected to a certain test, but it should not be necessary to have separate methods for each stabilizer. All the present tests are empirical and none has been sufficiently correlated with field service.

There are no tests by which stabilized mixes can be compared satisfactorily with top-soil or sand-clay mixes. Good sand-clay and top-soil will in every instance give very poor results when subjected to any of the tests used for stabilized soil. Top-soil and sand-clay soil will slake almost immediately when immersed in water, but mixtures of stabilized soils will frequently withstand as many as 200 cycles of alternate immersion and drying without serious damage. Yet we know from experience that certain sand-clay or top-soils give excellent service over a period of years, and it seems reasonable that we should compare the stabilized soil with such satisfactory soils and base our design on combinations that will give equal service.

The effect of organic matter and change of the ions adsorbed on soil particles is only partially understood. These factors may have great influence on the compaction of soils, the moisture retention, the affinity for bituminous materials, and the stability of soils.

Another problem connected with soil stabilization, but also of vital interest in the construction of all flexible-base roads, is that of thickness. At present, the choice of thickness for pavements of the flexible type is based on

guesses or on experience. Research leading to the development of rational principles of design founded on tests would be very valuable.

THE FUNCTION OF THE LABORATORY

In all soil investigations, the chief object should be to build better roads for less money. This does not mean that the first cost can always be reduced; but the prime object of all research should be to secure the most economical road over a period of years. The laboratory can be very useful in solving problems of this kind but there is also the danger that it will lose sight of the fact that a road which according to laboratory tests will be satisfactory in every respect may be too expensive for practical purposes. The laboratory should strive in every possible way to make its methods known and understood in the field, and to work in the closest cooperation with field forces.

Soil Stabilization Methods

By H. C. WEATHERS
DIVISION ENGINEER OF TESTS, FLORIDA STATE ROAD DEPARTMENT, GAINESVILLE, FLA.

THROUGH research and experiment, the highway departments of the southeastern states have achieved some gratifying results in recent years in the construction of stabilized roads. A considerable mileage of year-round serviceable roads has been built through sandy soil, with bituminous material, portland cement, or clay as the stabilizing agent. Where the native soil is clay, stabilization has been accomplished by adding sand to increase the internal friction, or cement or bituminous material to provide water-proofing and binding qualities.

All the southeastern states construct sand-clay bases for surface treatments and other types of wearing surfaces. Some of them do not surface the sand-clay bases on their third- and fourth-class roads, but use them as pavements or wearing surfaces if traffic is extremely light. Occasionally sand-clay occurs in nature in the proper percentages of silt, clay, and fine and coarse sand, but more frequently there is a lack of one or another of these constituents. The method of stabilization consists of testing the materials, computing the amount of clay to be added to the sand (or sand to be added to the clay), placing the materials in proper proportion on the previously prepared subgrade, and mixing them with disks and graders until a uniform material is obtained. The mixture is then compacted and shaped to the proper cross-section.

Some of the states have top-soil that can be used for base and surface construction. However, when used for surfacing, it dusts very badly in dry weather. To correct this condition, calcium chloride has in some cases been added as a stabilizer.

A SANDY GRADE IN FLORIDA—TYPICAL OF THE ROADS REQUIRING STABILIZATION

South Carolina has been the leader in soil-cement stabilization. Fairly heavy clay or sand-clay soils, as well as sandy soils, have been stabilized by the addition of portland cement to produce bases for surface treatments or other types of wearing surfaces. As this method of soil stabilization is comparatively new, it is advisable to discuss it in detail.

TEST METHODS FOR SOIL-CEMENT STABILIZATION PROJECTS

A preliminary investigation of the proposed project is made and representative samples of the different soils encountered are obtained and brought to the laboratory. Mechanical analyses and subgrade soil constants are determined on these samples.

The optimum moisture content for compaction by sheep's-foot roller is determined by the "modified" Proctor method on the neat soil and on mixtures of the soil with different percentages of cement. The Proctor method is "modified" in that instead of dropping the tamper through a distance of 12 in., the mixture is struck severely with the tamper from a height of 12 in. or more. This is necessary in order to obtain an optimum moisture content that will be satisfactory for field work, with the sheep's-foot rollers exerting a unit pressure of more than 150 lb per sq in.

Usually tests are made on three mixtures, one having a cement content estimated to be sufficient to stabilize the soil, one containing slightly more than this quantity of cement, and one containing slightly less.

After the optimum moisture content for compaction has been determined on each of the three mixes, a durability specimen is formed for each cement content by compacting the mixture of soil and cement in the Proctor mold at the optimum moisture content. The specimen is removed from the mold as soon as practicable and placed in the concrete curing room for seven days. Then the core is sawed, perpendicular to its long axis, into four approximately equal parts, and durability is measured by wetting-drying and freezing-thawing tests.

For the wetting-drying test, the specimen is submerged in water at room temperature for five hours, after which it is removed and dried in an oven at 160 F until its weight becomes constant. The cycle is then repeated. For the first five cycles the specimen is brushed lightly with a bristle brush and weighed at the end of each drying period. After it has completed five cycles it is brushed and weighed only after each second cycle.

For the freezing-thawing test, the specimen is placed in a special wire container, on blotting paper, and is put in the freezing cabinet for 24 hours, after which it is removed and allowed to thaw in the curing room for 24 hours. This constitutes one cycle. The material lost

THE FINAL PRODUCT OF THE SAND BITUMINOUS ROAD MIX PROCESS

during each cycle is retained in the container, and dried and weighed to determine the loss at the end of each cycle.

The quantity of cement to be used in the field is estimated from the results of the durability tests and experience with soils previously used possessing similar characteristics. No definite number of cycles or permissible percentage of loss has been established, but it has been found that losses will be very high if the quantity of cement is not sufficient. The prescribed field mix contains the minimum quantity of cement that will produce a material able to resist the durability tests reasonably well, plus a small percentage added as a factor of safety.

SOIL-CEMENT STABILIZATION CONSTRUCTION METHODS

After the existing road bed is graded and shaped, the soil to be stabilized is pulverized for the full width and to a sufficient depth to give a compacted thickness of about 6 in. The soil is pulverized as completely as practicable, and must be in this condition at the time the cement is applied. Also, when the cement is applied, the moisture content of the soil must be at or below a definite quantity that has been previously established in the laboratory. The cement is spread uniformly over the surface and immediately mixed with the loose soil by means of disk harrows, road machines, multiple-blade drags, or other implements until a thorough and intimate mixture is obtained. The mixture is then shaped to approximate line and grade. Immediately after mixing, the moisture content is determined and, if necessary, water is uniformly incorporated in such quantities that the resulting mixture will not have less than 90 per cent nor more than 115 per cent of the specified moisture content. After the cement is applied to any section, the work should be continuous until the final shaping and compaction is complete. If any of the operations are interrupted for more than two hours, or if the uncompacted cement-soil mixture is wetted so that the moisture content exceeds that specified by more than 25 per cent, the section affected is reconstructed by the addition of cement and further mixing until completed.

The mixture is compacted with sheep's-foot rollers to the greatest density practicable. The feet of the rollers when in contact with a plane surface, should be capable of exerting a pressure of at least 150 lb per sq in. The rate of operation and the number of rollers should be sufficient to insure compaction in $1^1/_2$ hours.

After compaction, the surface of the stabilized base course should be shaped to the required cross-section, and if necessary the surface should be loosened to remove any imprints left by the compacting or shaping equipment, until not more than one inch of loose material is obtained. This material is then thoroughly rolled with a roller of the flat-face wheel type weighing not less than eight tons. The finished soil-cement stabilized base is not opened to traffic until a wearing surface has been applied.

An alternate method of constructing this type of soil-stabilized road uses a machine that pulverizes the soil, mixes in the cement and water, and spreads the mixture. South Carolina has also been stabilizing soils in a manner similar to that just described, but using tar as the stabilizing material.

THE SAND BITUMINOUS ROAD MIX

A method of stabilizing sand, sandy silt, or loam soils which has proved very satisfactory originated in Florida several years ago. It is commonly known as sand bituminous road mix. The surface is prepared by traveling road-mix plants or by applying the bituminous material in successive applications with a pressure distributor and perfecting the mix with disk harrows, graders, and so forth. (A heating unit has been recently developed, which is attached to the rear of the grader blade. It is beneficial in drying out wet soil after rains, thereby decreasing the delay to work caused by excess moisture, and it also assists mixing operations in cool weather.) After the soil is uniformly mixed with the bituminous material and properly cured, it is compacted with rollers.

This method of stabilization permits the use of local materials so unstable that ordinarily they are impassable, and converts them into very creditable wearing surfaces or bases for surface treatment. The bituminous materials used include cut-back asphalt, coal tar, petroleum tar, pine tar, emulsified asphalt, and flux oil and hard powdered asphalt.

The majority of the states in this group have also used soil stabilization on weak subgrades on which concrete pavements were to be placed. This work has consisted mostly of utilizing available local material possessing a high degree of stability and mixing it uniformly with the existing unstable material. A weak fine sand, for instance, can be made sufficiently stable for use as a subgrade by adding proper percentages of silts, loams, coarser uniformly graded sands, stone screenings, and similar materials. In one case pulverized lime rock was used successfully. Bituminous materials are also used for subgrade stabilization in a manner similar to that previously described, but in smaller quantities.

TRAVELING PLANT IS SOMETIMES USED TO MIX THE SAND AND BITUMINOUS MATERIAL

An Alternate Method Is to Apply the Bituminous Material with a Pressure Distributor and Do the Mixing with Disk Harrows and Graders

Uplift Measurements at Holtwood Dam

Piezometric Observations on Thirty-Year-Old Concrete Structure Provide Much-Needed Data

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REANALYSIS of the maximum flood possibilities of the Susquehanna River, following the unprecedented discharges of 1936, raised a serious question as to the stability of the Holtwood Dam. A review of the dam design and a series of model tests soon made it apparent that a definite answer must await a reasonably accurate determination of uplift. Accordingly, holes were drilled in the structure and piezometric measurements were taken. According to Mr. Gisiger, no other uplift tests have ever been made in a similar manner. The technique evolved is a valuable contribution to engineering research.

DURING the summer of 1936, the Pennsylvania Water and Power Company made a number of piezometer uplift measurements on a dam which has been standing for about thirty years. Since published data on measured uplift are rather scarce, and moreover since no such measurements appear ever to have been made on a dam not originally provided with piezometer shafts, the results and method of obtaining them should be of general interest.

The incentive to take these measurements was the flood of March 1936, during which many dams in the northeastern United States were subjected to water elevations higher than any previously experienced and, in a number of cases, higher than those that had formed the basis of design. Among those is the Holtwood Dam of the Pennsylvania Water and Power Company on the Susquehanna River in Pennsylvania, a part of the 150,000-hp Holtwood hydroelectric development. (This dam was built under the name of "McCall's Ferry Dam" and is referred to under this name in articles published at the time of its construction.)

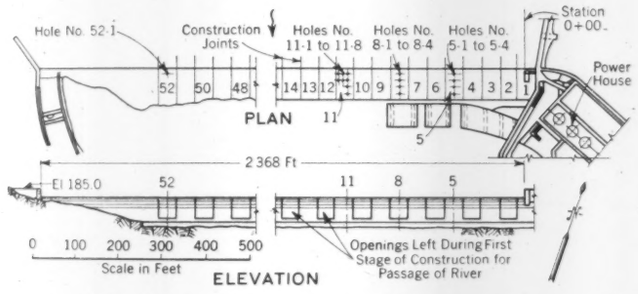


FIG. 1. PLAN AND ELEVATION OF HOLTWOOD DAM AND LOCATION OF TEST HOLES

As shown in Fig. 1, Holtwood Dam is an overflow ogee spillway with crest at El. 165.00, about 50 ft above the original low-flow elevation of the river and about 70 ft above the lowest point of the foundation. The underlying rock is a metamorphosed granitic schist containing many quartz veins and occasional fault seams. The crest is 2,368 ft long, straight, and is not surmounted by gates, piers, or any other permanent projection. However, it is normally provided with flashboards, 4 ft 6 in. high, thus producing a forebay elevation of 169.50 at the point of overflow of the flashboards.

The dam was constructed between 1906 and 1910 and was designed for a maximum water elevation of 182.5, corresponding to a discharge capacity of 700,000 cu ft per sec. On March 19, 1936, the forebay reached El. 184.5, corresponding to a discharge of about 870,000 cu ft per sec. Little concern would be felt for the safety of the dam during a repetition of this flood, but a study of the meteorological conditions preceding the high water made it apparent that a slight shift in the time-sequence of the rainfall might have resulted in a discharge of about 1,200,000 cu ft per sec. This latter flow, and the corresponding pond elevation, were accepted as the maximum against which all power-plant structures should be made safe.

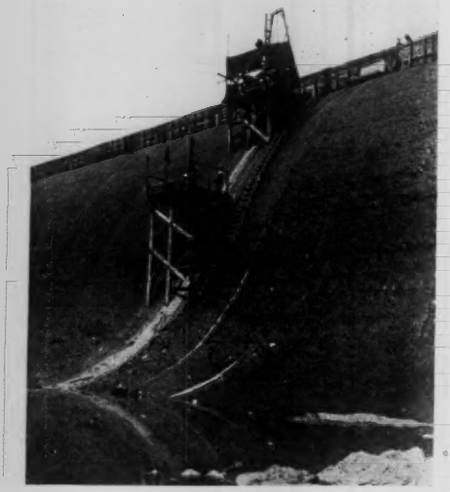
The pond elevation for a discharge of 1,200,000 cu ft per sec was determined as El. 187.9, or 5.4 ft higher than the elevation for which the dam was designed. This produced about 11.5 per cent more horizontal water pressure against the dam than the original design assumption and about 10.5 per cent more uplift, provided uplift is assumed to be the same fraction of the head at the face and toe of the dam as was used originally, and to vary between the two points in a straight-line ratio. This addition to the forces producing an overturning movement will not be reduced, as perhaps might be expected, by a higher tailwater elevation, but rather will be increased by the formation of a vacuum under the overfalling nappe when the depth of overflow becomes greater than 20 ft. Model tests showed that the vacuum might attain a value of 9.8 ft of water pressure at a point upstream of the crest line, and that it would extend quite a distance down on the ogee face.

The external forces that had to be considered in this case can be listed as follows: (1) headwater pressure, (2) silt pressure, (3) tailwater pressure, (4) uplift, (5) weight of overfalling water, (6) vacuum under nappe, and (7) weight of the structure. The magnitude of forces (1) and (7) could easily be established; and the combined effect of (3), (5), and (6) was determined by tests on a 1:30 model. There remained uncertainty with regard to silt pressure and uplift. Although the upstream side of the dam is silted up to an average elevation of 145, the effect of silt pressure on the location and slope of the resultant of all forces under the condition of maximum discharge is relatively slight. On the basis of the fairly well-known characteristics and weights of the silt in front of the Holtwood Dam, it was assumed that silt would add 27.5 lb per cu ft to the liquid pressure of the water. At the outset it was believed that silt might perhaps have the effect of sealing the foundation joint or the lift joints and thereby reduce uplift pressure. However, the results of the investigation did not lend much support to this opinion.

The magnitude of uplift remained the most important factor, then, on which the safety of the dam had largely to be judged.

The original design of the dam had been governed by the assumption that for the extreme condition of headwater assumed (El. 182.5), and with uplift on the full

base decreasing from 50 per cent of the headwater pressure to 50 per cent of the tailwater pressure, the resultant should remain within the middle third. No foundation drainage had been provided nor were there any provisions for drainage inside the body of the dam. Neither had any of the now customary means to seal horizontal or vertical construction joints near the upstream face been used. There was considerable evidence, however, that the foundation joint had been cleaned carefully and that lift joints had been keyed together with a large amount of bonding stones embedded in the top of each pour. The fact that there were very few places in the neighborhood of vertical or horizontal joints that were damp from leakage during times of no overflow gave further evidence of the soundness of most joints. Horizontal lift joints are from 3 to 7 ft apart, the average being about 5 ft. The concrete aggregate was crushed trap rock, and one barrel of cement per cubic yard of concrete had been used. After 25 years of service, surface deterioration of the concrete was evident to more or less degree, especially along joints, but as a whole the condition of the concrete, where visible, could be classified as good, considering its age and severe exposure.



DRILLING AND MEASUREMENTS IN PROGRESS AT HOLES 11-2 AND 11-3

WIDE VARIATION IN UPLIFT ASSUMPTIONS

When the adequacy of the original design to withstand a flood much in excess of 700,000 cu ft per sec was questioned, it became evident that no satisfactory answer could be given without some positive knowledge about the actual magnitude of uplift. Authorities, textbooks, and prescriptions as to what uplift must be expected or should be assumed differ greatly, and trends of opinion show considerable variance at different times and in different countries. For instance, a German code for dams (1930) allows a variation of from 20 per cent of full theoretical uplift (taken as an uplift pressure decreasing along a straight line from full headwater to full tailwater) for good rock foundation to 40 per cent for poor rock foundation. French government engineers are using 50 to 75 per cent for their irrigation dams in Algeria. Wachusett Dam, Kensico Dam, and Norris Dam of the TVA are designed for 67 per cent, and the Assuan Dam for 100 per cent, while for the New Croton Dam, built shortly before the Assuan Dam, no uplift was considered. The Arizona Code for Dams (1933), the only instance known to the writer of a legal ruling on this question in the United States, provides that where no foundation drains are used, uplift must be assumed to be 75 per cent of full headwater at the heel, decreasing to full tailwater at the toe.

Actual determinations of uplift under existing dams appear to have been made relatively seldom in proportion to the importance of this question and the amount of theorizing that has been done about it. Piezometer pipes have been built into some dams, from the foundation to a tunnel or other point at which the water level in the pipe can be observed and measured. Uplift measurements made in this manner were published in CIVIL ENGINEERING for September 1932, page 578, by Ivan E. Houk, M. Am. Soc. C.E., of the U. S. Bureau of Reclamation. Another valuable paper—probably the most extensive contribution to this subject—is that by Julian Hinds, M. Am. Soc. C.E., TRANSACTIONS of the Society, Vol. 93 (1929), page 1527.

The information derived from the published results of these measurements, however, does not give a complete answer for the Holtwood Dam. For one thing, the data apply mostly to dam foundations that were pressure-grouted and provided with drains, features not incorporated in the Holtwood Dam. The question was raised also whether a pipe grouted into the foundation before concrete was poured would give a truly representative value of uplift, since the very placing of the pipe might cause a local irregularity in the foundation joint. Moreover, the stability of the Holtwood Dam was rather more questionable for horizontal lift joints at intermediate elevations than for the foundation joint itself, and no published data could be found regarding intermediate joints.

Accordingly, it was decided to sink core drill holes of 3-in. diameter through the dam into the foundation at various places and to use these holes as piezometers. No definite number of holes was decided on at the outset; when it was assumed that sufficient information had been obtained, 17 holes had been drilled, 13 of which went completely through the structure into rock. Twelve of these holes were arranged in 3 rows of 4 each in planes perpendicular to the axis of the dam, so that the pressure gradient could be established by 4 points in each of 3 transverse profiles. Of the remaining 5 holes, 4 were located near one of these profiles and the last was alone near the west end of the dam (Fig. 1).

The numbering of these profiles corresponds to the numbering of the sections into which the dam is divided by the vertical constructions joints, which are spaced about 40 ft apart. Holes were drilled in Sections 5, 8, 11, and 52, and individual holes were numbered 1, 2, 3, and 4, in accordance with their relative position in the transverse profile (Fig. 2). The choice of the test sections was somewhat influenced by the fact that Section 11 showed poor lift joints and some seepage on the downstream side, and that Section 52 had the lowest silt elevation on its upstream side. The results of the observations show that the first of these facts had a marked significance, while the second had none whatever.

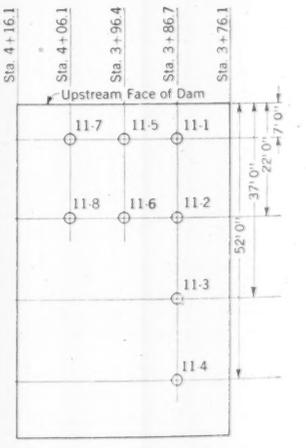


FIG. 2. PLAN AND NUMBERING OF TEST HOLES IN SECTION 11

In Other Sections, the Test Holes Were on the Center Line, with Spacing from Upstream Face as Shown Here

Since it was considered necessary to obtain a positive distinction between uplift in the foundation joint and uplift in lift joints, it was not permissible merely to measure the height to which the water rose in each hole, because this water might have entered at any horizontal plane intersecting the hole. Special apparatus was there-

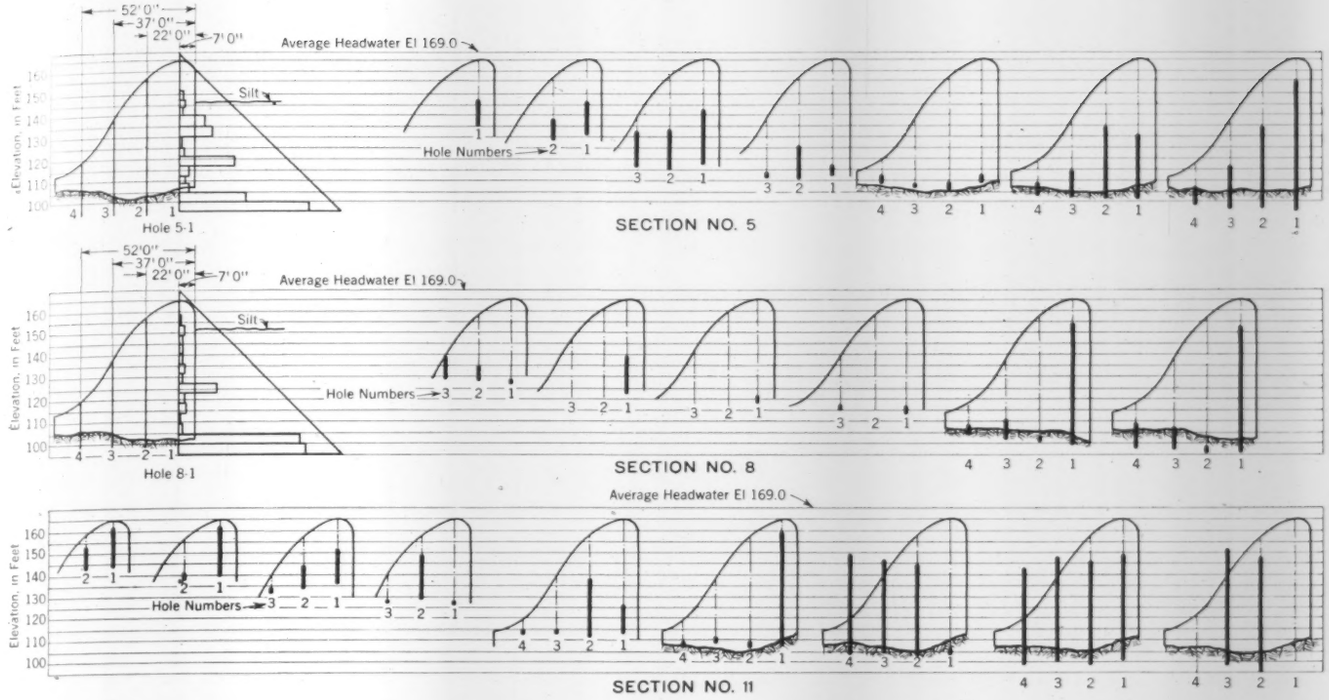


FIG. 3. UPLIFT MEASUREMENTS IN SECTIONS 5, 8, AND 11

Uplift Is Plotted Vertically Upward from Elevation at Which It Was Observed. At the Left of the First Two Rows of Diagrams, the Measurements for Holes 5-1 and 8-1, Are Collected and Plotted Horizontally

fore used which made it possible to isolate a 5-ft length of hole at any desired elevation by means of concentric double pipes and expanding rubber rings. After the apparatus was set in place and the rubber rings expanded, the 5-ft section of hole between them was shut off from the remainder of the hole, but was connected through the inner one of the concentric pipes, with the working platform on the face of the dam above the hole. Measurements were made by first blowing out the water initially present in the 5-ft space with compressed air, and then observing its subsequent rise in the pipe by means of a wooden float suspended from fine copper wire. In a few instances, where the water would have risen above the top of a hole, the end of the riser pipe was connected to a pressure gage and the head measured as pressure.

As would be expected, the water came up rather slowly in most cases and a period of up to 10 hours was required before a stationary elevation (which was considered to correspond to the uplift pressure) was reached. In each test, after the stationary maximum elevation was arrived at, a certain amount of water was poured into the hole, and the observation was continued in order to see whether the water would run out to the previously observed head. In most cases it did so within narrow limits.

The forebay elevation varied little during the tests, and averaged about 169.0, that is, 4 ft above the dam crest and 6 in. below the top of the flashboards.

The results of all measurements are shown graphically in Figs. 3 and 4 and are amplified in tabular form in Table I. It must be remembered in reviewing the recorded data that only the holes next to the upstream face are truly representative of the undisturbed condition of the dam. Holes 2, 3, and 4 of each transverse section may be influenced by water standing in holes upstream of the ones measured. In other words, if at a given elevation a hole other than the one adjacent to the upstream face shows no uplift, it is a positive indication that no uplift is present in the vicinity of that hole at that particular elevation. If, at another elevation, the same hole shows uplift, it must be suspected that a seepage plane extends from the 5-ft vertical portion under test to the next hole upstream. The latter hole, however, may have been filled with water entering at a quite different elevation; and it is possible that if the upstream hole had not been drilled, a lesser uplift or no uplift would have been measured at the point in question. For instance, Hole 11-2 shows considerable uplift at El. 130, while Hole 11-1 shows practically none at the same elevation. This is not a simultaneous condition, however, because the uplift shown for Hole 11-1 was measured before Hole 11-2 was drilled; when the uplift shown for Hole 11-2 was measured, Hole 11-1 was standing full of water to its natural level, which in this case would be the one measured and shown for El. 110. This qualification is necessary for a correct interpretation of the test results. It means that uplifts measured in Holes 2, 3, and 4 may be higher, but cannot be less, than those which could have been measured without the disturbance to the original condition that is caused by the existence of Hole 1.

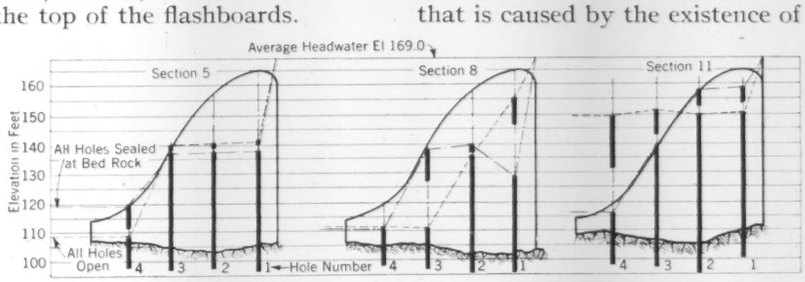


FIG. 4. SIMULTANEOUS MEASUREMENTS AT FOUR HOLES

It will be noted that out of the 6 holes—5-1, 5-2, 8-1, 11-1, 11-2, and 11-3—only 11-1 shows more uplift for the foundation joint than for joints in the rock below, while in the others the uplift continues to increase

with the depth into rock. The existence of considerable —that is, almost full—uplift pressure at depths of up to 10 ft below the foundation line serves to emphasize the importance of a good foundation for the stability of a dam. The foundation conditions under the Holtwood Dam are probably as good as could be hoped for in any gravity dam, and the evidence of seams more pervious than the foundation joint itself shows that, in cases where dams have to be set on less desirable rock strata, uplift must be given full recognition.

SUMMARY OF SIGNIFICANT OBSERVATIONS

Whether any further and general conclusions should be drawn from these investigations may be a matter for discussion. The following summarization is believed to contain what there is of significance, and was taken as a basis for judgment as to the stability of the Holtwood Dam:

1. The four holes drilled through to rock next to the upstream face of the dam all showed substantial amounts of uplift at or near the foundation joint, varying from 51 to 84.5 per cent of full head of forebay water at joint elevation, and averaging 73.7 per cent.

2. The average maxima of uplift measured at or below the foundation joints, in percentage of full headwater pressure, are as shown in Fig. 5 (*a*).

3. The maximum uplift measured (in any of the 4 holes next to the upstream face drilled through to rock) for any horizontal joint above the foundation joint is 72.7 per cent of full headwater pressure at joint elevation. The average of the 4 holes, however, is only 39.9 per cent.

4. The average maxima of uplift measured for planes above the foundation joint are as shown in Fig. 5 (*b*).

The figures indicate that in the Holtwood Dam relatively more uplift pressure is active in the foundation joint than in any lift joint above. This appears reasonable and likely to be the case also for other dams except for lift joints which show evidence of leakage.

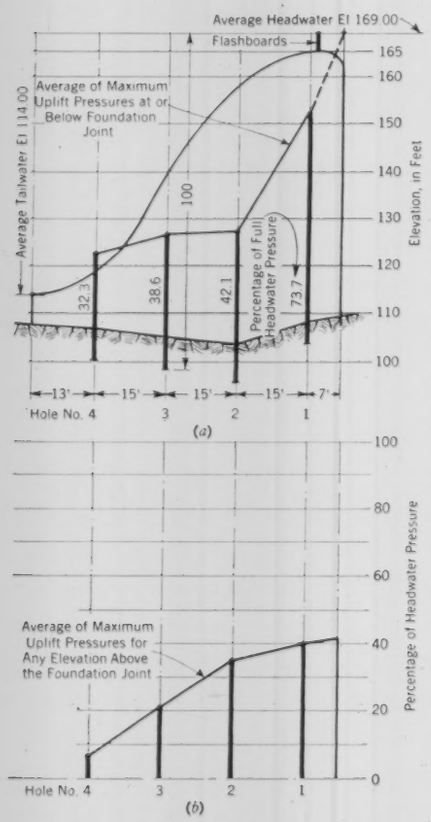


FIG. 5. AVERAGE PRESSURES MEASURED (*a*) AT FOUNDATION JOINT AND (*b*) ABOVE FOUNDATION JOINT

After these tests were completed and the results evaluated, the engineers of the Pennsylvania Water and Power Company were satisfied that uplift conditions were at least not worse than had been assumed previously; and for the upper parts of the dam (which, when analyzed alone, are less stable than the dam as a whole), they were rather better. It is realized, however, that the results obtained are strictly applicable only to the condition under which they were produced—that is, with low tailwater and no overflow. For the condition of high tailwater, dependence must still be placed on judgment, but it is hoped that these data may afford some guide to that judgment, both at Holtwood and elsewhere.

TABLE I. RESULTS OF UPLIFT MEASUREMENTS

(1) Hole No.	(2) Foundation Joint El.	(3) Bottom El. of Observed Sec.	(4) Final observed Water El.	(5) Height of Water in Feet Above Bottom of Observed Sec. ((4)–(3))	(6) Depth of Water in Reservoir in Feet Above Bottom of Observed Sec. (169.0–(3))	(7) Percentage of Uplift $\left(100 \times \frac{(5)}{(6)}\right)$
5-1	106.4	135.3	147.3	12.0	33.7	35.6
		130.8	145.8	15.0	38.2	39.2
		116.8	141.8	25.0	52.2	47.9
		100.3	130.3	30.0	68.7	43.7
		95.8	154.3	58.5	73.2	80.0
5-2	103.5	128.6	138.4	9.8	40.4	24.2
		115.0	132.9	17.9	54.0	33.1
		110.5	125.3	14.8	58.5	25.3
		101.5	134.7	33.2	67.5	49.2
		97.0	134.9	37.9	72.0	52.6
5-3	104.0	115.6	132.0	16.4	53.4	30.7
		102.2	114.8	12.6	66.8	18.9
		97.2	116.3	19.1	71.8	26.6
5-4	107.0	108.2	112.7	4.5	60.8	7.4
		103.7	109.0	5.3	65.3	8.1
		98.7	107.6	8.9	70.3	12.6
8-1	101.8	149.3	151.8	2.5	19.7	12.7
		122.3	139.4	17.1	46.7	36.6
		99.8	154.5	54.7	69.2	79.0
		95.3	152.4	57.1	73.7	77.5
8-2	102.1	146.4	150.5	4.1	22.6	18.1
		136.2	142.6	6.4	32.8	19.5
		127.9	135.0	7.1	41.1	17.3
		95.9	98.5	2.6	73.1	3.5
8-3	105.2	128.5	137.8	9.3	40.5	23.0
		115.0	116.2	1.2	54.0	2.2
		101.5	110.2	8.7	67.5	12.9
		97.0	106.3	9.3	72.0	12.9
8-4	105.6	103.4	107.8	4.4	65.6	6.7
		98.4	109.3	10.9	70.6	15.4
11-1[1]	109.5	144.6	161.6	17.0	24.4	69.7
		140.1	161.1	21.0	28.9	72.7
		135.6	151.5	15.9	33.4	47.5
		113.1	126.1	13.0	55.9	23.2
		108.6	159.6	51.0	60.4	84.5
		100.5	149.2	48.7	68.5	71.0
11-2	104.7	145.5	155.7	10.2	23.5	43.4
		143.0	153.6	10.6	26.0	40.8
		134.0	144.3	10.3	35.0	29.4
		129.5	149.6	20.1	39.5	50.9
		111.5	137.8	26.3	57.5	45.7
		103.0	144.4	41.4	66.0	62.6
		98.5	145.3	46.8	70.5	66.4
		95.5	147.2	51.7	73.5	70.3
11-3	105.6	131.5	134.0	2.5	37.5	6.7
		118.0	120.9	2.9	51.0	5.8
		105.0	146.7	41.7	64.0	65.2
		100.0	147.3	47.3	69.0	43.2
		97.3	151.9	54.6	71.7	76.2
11-4	107.4	103.5	149.2	45.7	65.5	69.7
		98.5	142.5	44.0	70.5	62.4
11-5[2]	.....	145.1	147.4	2.3	23.9	9.6
		142.2	151.9	9.7	26.8	36.2
11-6[2]	.....	142.3	151.4	9.1	26.7	34.0
11-7[2]	.....	149.6	152.1	2.5	19.4	12.9
		145.1	149.1	4.0	23.9	16.7
		142.9	151.7	8.8	26.1	33.7
11-8[2]	.....	142.6	155.4	12.8	26.4	48.5
52-1	115.0	113.8	117.3	3.5	55.2	6.3
		109.3	132.4	23.1	59.7	38.6
		104.3	137.4	33.1	64.7	51.1

[1] Seepage appearing on downstream face of dam at El. 146.0 (lift joint).
[2] Holes 11-5 and 11-7, and Holes 11-2, 11-6, and 11-8 were observed simultaneously at same elevations. All other holes in Section 11 were open, with water standing to its natural level.

The work described was carried out by the engineering and test departments of the Pennsylvania Water and Power Company. Albert S. Crane, M. Am. Soc. C.E., acted as consultant on this and other investigations undertaken by the company after the 1936 flood.

Mapping in Duval County, Fla.

Coordinates Based on National Grid; Topographic Map Proves Its Worth

FROM A PAPER PRESENTED BEFORE THE SURVEYING AND MAPPING DIVISION AT THE 1938 SPRING MEETING

By ARTHUR N. SOLLEE

ASSISTANT COUNTY ENGINEER, DUVAL COUNTY, JACKSONVILLE, FLA.

IN the latter part of 1930 the incoming Duval County engineer found that he had inherited an accumulation of many road right-of-way locations and surveys, each of them entirely independent of every other. No authoritative county road map was in existence. Realizing the necessity of coordinating these and all future county road surveys, it was decided to set up a local system of plane coordinates and plat all surveys on sheets 28 by 40 in. in size, to a scale of 1 in. to 400 ft.

A well-defined point near the center of the county was selected as the point of origin. From it, various new traverses were run radiating towards the county boundary, the closures being effected by special traverses run across country or by tying in to existing road locations. Ties were also made to subdivision boundaries. All these surveys were required to have a closure of at least 1 in 5,000 before being placed on the coordinate sheets. As no extra funds were provided, this work was done as a "spare time" assignment of the engineering department.

As soon as practicable, a two-man topographic party was placed in the field. The first topographic surveys were made of the more densely populated areas adjacent to the city limits of Jacksonville, and of those areas in the populated rural districts where drainage conditions seemed to be the worst.

Topography was taken by stadia. The somewhat unusual method adopted for carrying levels is worthy of mention. Between points of known elevation, all H.I.'s were read directly by means of the plumb bob, which was allowed barely to touch the top of the station over which the transit was set, and was then swung over to one of the tripod legs which previously had been calibrated. A back sight was then taken, and the mean of the differences between the respective H.I.'s and rod readings gave the correct difference in elevation of the two stations. The results were very satisfactory.

MAP PROVIDES DATA FOR PLANNING WORK PROJECTS

The coordinate and topographic mapping was carried on intermittently over a period of three years until the FERA started to function. Then, on only a few hours' notice, Duval County was called upon to provide work projects for several thousand men. The value of the survey work was at once apparent, for a quick perusal of the maps indicated what work could be started immediately and advantageously. The result was that every man was put to work without delay on some worthwhile job. In the next few years hundreds of road and drainage projects were sponsored by the county. During this period considerable pioneer work was done by members of the engineering department in educating the leading civic organizations as to the benefits to be derived from a county topographic map. This work bore fruit, for in 1937 the Duval County Budget Commission created a special fund to provide for continuance of the coordinate and topographic surveys.

In the meantime, the U. S. Coast and Geodetic Survey had covered nearly three-quarters of the county with first- and second-order control. However, it was not until the early part of 1938 that the data pertaining to all the stations became a matter of public record. Duval County immediately decided to make use of this valuable information and convert the local system of plane coordinates to that of the Coast Survey's transverse Mercator grid projection, North American datum of 1927.

This meant the abandonment of several years of calculations and the refiguring of every traverse that had been plotted on the topographic or coordinate sheets. The sheets, however, did not have to be redrawn. As each old traverse is refigured, the new coordinates applicable to each individual sheet are noted and the four most appropriate points are used to mark out the new grid. The new horizontal lines are determined by the points nearest the extreme right and left center, and the vertical lines by those in the upper and lower center of each sheet. The new grid is drawn in with green ink, to distinguish it from the red grid lines of the old system.

HIGH ACCURACY IN FIELD WORK

In setting up the new grid it has been deemed advisable to aim for a higher degree of accuracy in the office and field work than was formerly required. Angles are now turned six times, instead of twice. Further, although the tape is not corrected for temperature, the chaining of any one traverse is required to be done within a narrow temperature range. It can be understood readily what difficulties would develop if, for instance, in a 12-mile traverse the first five miles were measured with the temperature around 40 F and a week later the remainder were measured at a temperature of 75 F. The traverse might close within proper limits but the intermediate points would be in considerable error. This variation in weather is quite prevalent in north Florida. In all the traverses run so far, the average angular error for each set-up has been approximately 5 sec. This indicates very careful instrument work, for the transits are over 12 years old and the verniers read only to 1 min. No county road traverse is used unless it closes within the limits prescribed for third-order control or better. This accuracy suffices for county purposes, and is far higher than that of the average acreage survey made by private surveyors.

Even in its comparatively short existence, the local coordinate map system of Duval County, though incomplete, has been of inestimable service to the tax assessor and to title companies, land appraisers, surveyors, health officials, and countless others. Those interested in real estate have been particularly benefited by the topographic map, for, as all pertinent facts are shown, it is a simple matter to estimate the cost of proposed land developments and appraise properties.

A multitude of advantages are obtained when any large area is mapped by the use of a plane coordinate system, but Duval County is one of the relatively few counties in the country with the additional advantage of a system based on the national grid. By starting a survey from any one of the county road monuments, a local survey can be coordinated with the first-order control net of the country. It is thus possible to fix permanently any surveyed parcel of land by giving the coordinates of its corners, from which its geographical position can be defined—a decided advantage over a description that merely gives its position relative to adjacent parcels.

Safety in Design of Florida Highways

A Review of Principles and Practices That Reduce Driving Hazards—Abridged from a Paper Presented Before the Highway Division at the 1938 Spring Meeting

By HARRY J. MORRISON

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

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IT is the purpose of this article to set forth briefly a number of principles in the design of safe highways. The references are specifically to current practice in the state of Florida, but they are, with few exceptions, of quite general applicability. The principal items to be discussed include embankment slopes, divided highways, horizontal and vertical alinement, superelevation, and Y- and T-intersections.

In Florida the highway engineer finds no mountains to be crossed and no valleys to be followed. There are, on the other hand, many square miles of nearly level topography—locally known as "flat woods"—with many shallow ponds and swamps. His chief problem in such terrain is to dispose of the surface water, either by constructing embankments to raise the road or by digging drainage ditches to lower the high-water level.

Where the width of right of way is 100 ft or more, embankment slopes, inside slopes, and back slopes are now constructed to a 1 on 6 slope up to a height of 6 ft. If slopes steeper than 1 on 4 are required, a guard rail is provided. (A vehicle can with safety run off, or along, a 1 on 4 slope without turning over.) It is questionable whether much can be gained in either safety or appearance by making slopes flatter than 1 on 6, except where the slope extends into a body of water and is subject to wave action. For embankments on curves, it may be desirable to place a guard rail on the outside to indicate a change in direction, even though the fill is not high enough to require protection.

FLAT EMBANKMENT SLOPES CHARACTERIZE THE FLORIDA HIGHWAYS
The Striped Appearance Is Caused by the "Sprigging," Which Is Set in Rows. In Florida, Slopes Cannot Be Seeded as in the North

STABILIZING SHOULDERS AND SLOPES

Shoulders and slopes are planted or seeded to grass. Difficulty is experienced in maintaining grass in some of the fine-grained sands that contain no binder material. A 2-in. layer of good top soil or muck spread over the slopes is helpful, but has not proved entirely successful. A 6-in. layer of top soil would remedy the trouble. However, stable shoulders and slopes can be secured by adding a quantity of top soil or muck and mixing thoroughly with the sandy soil to a depth of 6-in. so as to obtain a bearing value of not less than 30 lb per sq in. This also provides a soil that will grow a satisfactory stand of grass. Loose sand shoulders are a hazard to traffic.

Roadbeds have been widened from the original standard of 30 ft to 36 and 40 ft, with pavements 22 ft in width. On main routes, two 11-ft lanes divided by a center strip 4 to 6 ft wide with a contrasting surface, are now being constructed. It has been found on such roads that traffic voluntarily follows the concrete and uses the center portion (a black-top surface) only for passing.

Improvement of the north and south roads leading into Jacksonville provides for two 20-ft paved lanes with a 20-ft parkway of grass between the lanes, on a 125 to 150-ft right of way. With this type of layout, openings for traffic in the parkway along the open highway should preferably be made at intervals of not less than a half mile.

The alinement of the roads constructed in Florida since 1920 has been reasonably direct and curvature has been generally satisfactory. It is the practice to construct on tangents, with curves as flat and as long as practicable, and preferably not sharper than 2 deg. With the exception of approaches to cities and towns, no curves as sharp as 6 deg have been used. Some objection might be raised to such long curves on the ground that impatient drivers may be tempted to pass on them. Objection might also be raised to long tangents, on the ground that glare from the lights of approaching cars is objectionable, and that the monotony of straightaway driving causes motorists to fall asleep. However, experience in Florida has been that the straight road is not the hazard to careful drivers that are sharp and frequent curves.

In Florida alinement over hills on a tangent with long grades not exceeding 5 per cent appears preferable to curvature with 5 per cent grades of less length; however, in such cases the design is influenced by local conditions.

Compound curves with a great difference in radii should be avoided. With reverse curves, there should not be less than 300 ft of tangent between the curves to provide for the runoff from superelevation. Short tangents between two curves in the same direction give a broken-back appearance; compounding of the curves without tangent gives a much more pleasing effect.

In Florida all curves are superelevated, beginning with 0.02 ft per ft for curves of less than 1 deg and increasing to a maximum of 0.08 ft per ft for those of 6 deg. The outer edge of a 1-deg curve without superelevation ap-

pears to the motorist lower than the inner edge; this constitutes a mental hazard and causes the driver to pull towards the center of the road. The state standard provides for eliminating the crown on curves and constructing a straight cross-section.

It should be noted that excessive superelevation may constitute a definite hazard. Flat-body trucks without sideboards are used in hauling boxes of citrus fruit from the groves to the packing houses. The boxes are piled high on the truck bodies, and the trucks cannot pass around curves with heavy superelevation without losing some of the load. The same condition applies to trucks hauling logs piled crosswise and held in place by a single chain passed over the top.

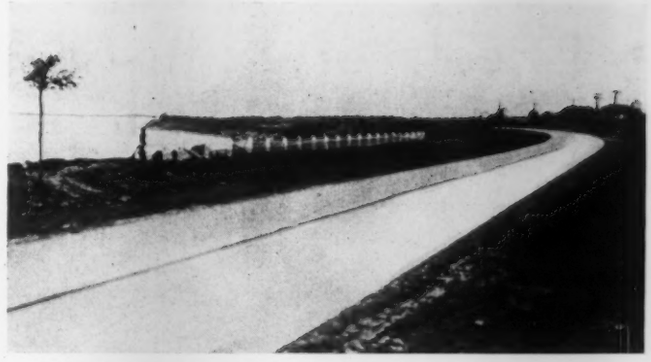
Rolling grades on long tangents are not objectionable except in appearance, but secondary rolls in grade must be limited so that vehicles will not disappear from the line of visibility. Horizontal curves at vertical curves should completely cover the vertical curve. The sight distance on vertical curves should exceed that on horizontal curves at the same point. A horizontal curve lying wholly within the limits of sag vertical produces the effect of a sharp bend rather than of pleasing alinement.

DESIGN OF Y- AND T-INTERSECTIONS

At Y-intersections better results appear to have been obtained by constructing a triangular island than by leaving the intersection open. The base of the island should be sufficiently wide to permit traffic to stop before turning, without encroaching on the main highways, and the base should be rounded so that traffic can make a complete turn in any direction. An intersection approached by curves of long radius without an island often places a motorist in a hazardous position as the result of another motorist's failing to keep to the right of the center line or cutting a left turn. The island provides a place of refuge for waiting or turning motorists.

Right-angle intersections of the T-type on main roads have been constructed with and without islands. Frequently the controlling element is the lack of right of way. Where there are no islands, even if signs are placed in advance and opposite the leg of the "T," drivers frequently fail to realize that they are approaching a dead end. This occurs more frequently at night. The placing of small reflectors at 2-ft intervals across the pavement lessens the hazard for night traffic.

Where no islands are constructed, T-intersections have usually been rounded with curves of 50-ft radius. Drivers, particularly those with trucks and trailers, complain that this radius is too short. Where islands have been constructed with curves of 200-ft radius in each direction, drivers are inclined to cross the area in every direction, and to overcome this situation a plate guard rail has been erected on all three sides of the island a few feet back of the edge of the pavement. By widening the pavement on the main road on the opposite side from the leg of the "T," opportunity is provided for drivers wishing to make a left turn to slide out of line and stop until a break occurs in the traffic on the main road. This avoids delay to traffic and possibly a rear-end collision.



PREVENTING EROSION OF EMBANKMENT SLOPES
Guard Rail Marks Location of a High Embankment. A Small Fill Has Been Placed Along Embankment Crest to Make Side Ditch Continuous. Drainage Is Collected and Carried Down Slope in Pipe

On city streets, curbs are constructed as a buffer to parking, and to keep vehicles from running over the sidewalk. Frequently, at filling stations on street corners, the curb is omitted along the entire frontage—even around the return. This permits traffic to enter and leave the station property from every direction and to cross the sidewalk at street corners, creating a definite hazard to the pedestrian. Wherever traffic leaves the street and crosses the sidewalk it should be confined to definite lanes, and in no case should the raised curb around the return at the intersection be omitted, as this provides a safety island. Entrances should be limited to a width of 20 or 30 ft.

The speed of motor vehicles has increased beyond the range of the headlights. A driver traveling at 40 miles per hour cannot see a pedestrian in dark clothes in time to stop. In order to eliminate the hazard of pedestrians walking on the roadway pavement, especially in the vicinity of cities where there is considerable pedestrian traffic, sidewalks with a surface at least equal in quality to that of the pavement have been constructed.

In Florida range cattle constitute a serious hazard to traffic. Owners of herds as large as a hundred head frequently pasture them in open range, with the result that many cattle feed on the grass of the shoulders and slopes of the roads. Under these conditions, the fencing of all highways by the state, as some have advocated, would be of little value unless the legislature passed a law requiring that all live stock be kept off the roads. The fencing of the highways, if required to be done by the state, would be a serious drain on highway funds. The elimination of this hazard is a problem for the legislature.

I have attempted here to outline a number of design practices that make for safe highways. In conclusion, I wish to stress that continued progress in design for safety depends upon our learning more about the cause and location of accidents. If this information could be collected and made available it would assist in correcting dangerous conditions.

THIS VIEW ILLUSTRATES THE TYPE OF GRADING IN NEARLY LEVEL TERRAIN, WITH GRASS SHOULDERS AND SLOPES

Effects of Industrial Wastes and Sewage on Shellfish and Fin Fish

By L. M. Fisher

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As the amount of industrial and domestic wastes discharged into our rivers and coastal waters increases, the problem of maintaining fish life in these waters becomes more serious. Mr. Fisher describes in detail the effects of various waste products on aquatic life, and urges a comprehensive program of research to discover methods of utilizing industrial wastes so that they need not be discharged into streams. His paper, here presented in abbreviated form, was on the program of the Sanitary Engineering Division at the Society's Spring Meeting in Jacksonville, Fla.

THE effects of industrial wastes and sewage on shellfish and fin fish are of direct importance not only to those engaged in the fishing industries, but to everyone who depends upon fresh-water fish or sea food for a part of his diet. While the subject covers only one phase of the broad problem of water pollution, it has a direct bearing on public health because shellfish have been involved more or less frequently in the spread of disease. It also has an indirect effect on health because pollution of coastal waters tends to make certain valuable sea food scarcer and more expensive, thus depriving a part of the population of the benefits of foods rich in iodine, iron, copper, and other essential elements, and vitamins.

Throughout the country there has been a progressive but irregular increase in pollution of streams by industrial wastes. Among the causes of this increase are the rehabilitation of the fermentation industries, the sudden growth of the cellulose textile industry, the development of the mid-continental oil fields, and the gradual extension of mining. Twenty years ago all the tributaries of the Ohio River, with the single exception of the Monongahela, were alkaline. Now the Allegheny in Pennsylvania, and many of the streams in West Virginia are acid most of the time, and the acid line in the Ohio River is being extended further down each year, although the mine-sealing operations recently undertaken give promise of retarding this encroachment. Another invasion by trade-waste pollution may be expected in southern streams and coastal waters as a result of the recently developed process for manufacturing paper pulp from slash pine.

While water is being polluted by trade wastes throughout the country, the problem is more acute, generally speaking, in the section north of the Ohio and Potomac rivers and east of the Mississippi River, which contains 65 per cent of the total urban population.

The value of the catch of 40 species of edible fish, as reported by the U. S. Bureau of Fisheries in 1934, was $70,905,000, and about 73 per cent of this income was derived from species of fish that may be subject in greater or less extent to the effects of coastal pollution. The Bureau of Fisheries has not attempted to lay out or survey the number of miles of streams throughout the country affected by pollution, nor has it attempted to determine the precise economic effect of pollution on the fisheries. But it has studied the physiological or pharmacological aspects of the problem, and has established standards of water purity necessary for the survival of fish.

Sewage and industrial wastes affect shellfish and fin fish directly in one or more of several ways (Table I). They may decrease the oxygen content of the water to a point below which fish life cannot be sustained (usually stated to be about 2 ppm). They may destroy fish by increasing the acidity, alkalinity, or salt content of the water, or by introducing toxic substances; or they may increase the turbidity so as to exclude light and prevent the growth of food. Again, they may deposit a blanket on the bottom of the stream so as to destroy the fish food found there. Some wastes (particularly those containing phenal compounds) impart disagreeable or repulsive odors or flavors to fish or shellfish, and others produce unnatural discoloration which makes the fish objectionable to would-be consumers.

The most frequent offenders in decreasing the oxygen content of waters are domestic sewages and those industrial wastes containing large quantities of organic matter, as the wastes from dairies, packing plants, canning plants, breweries, distilleries, beet-sugar plants, saw mills, and starch and textile industries.

The polluting material which reaches our streams in the greatest volume, and which is detrimental to fish over the largest stream-bed area, is probably acid mine wastes coming principally from coal mines. There are thousands of mines, both active and abandoned, discharging acid drainage which in the aggregate amounts to thousands of tons of concentrated sulfuric acid daily. A considerable reduction in acid from abandoned mines has been effected in recent years by a WPA mine-sealing project sponsored by various state health departments.

Discharge of sewage into our streams or coastal waters,

Table I. Ways in Which Various Industrial Wastes Are Harmful to Fish Life

Type of Waste	Decrease Oxygen	Add Acid	Add Alkalinity	Add Salt	Add Turbidity	Blanket Bottom	Toxic
Mining flotation wastes					x		
Coal and iron mines					x		
Crude oil						x	x
Salt water from oil wells				x			
Municipal sewage	x		x				
Dairy wastes	x	x					
Packing plants	x	x					
Canning plants	x	x					
Breweries	x	x					
Distilleries	x	x					
Beet sugar and pulp wastes	x	x					x
Paper pulp wastes	x		x			x	x
Sawdust	x						x
Coal-gas waste							x
Lubricants and refinery wastes						x	x
Laundry and wool washings			x				
Chemical wastes							x
Tannery wastes		x	x			x	
Tin-plate and wire mills		x					
Starch wastes	x						
Textile wastes	x	x					
Citrus fruit product wastes		x					
Winery wastes		x					
Electroplating		x					
Erosion					x		

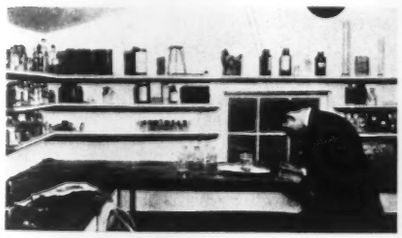
in addition to decreasing the oxygen content of the water, may result in forming sludge deposits on the bottom, and films of grease and scum on the surface, which tend to interfere with the absorption of oxygen from the air and to destroy small forms of aquatic life. In some waters the release of hydrogen sulfide from decomposing sludge also destroys aquatic life. Not infrequently sewage contains industrial wastes and poisons, discharged either by design or accident. Such substances may cause great destruction of fish life—as occurred at Buffalo, N.Y., in November and December 1937, when hundreds of tons of fish, valued at more than a million and a half dollars, were killed by the discharge of poisonous industrial wastes.

PLANTS OF ALL SIZES SUPPLY THE SHELLFISH MARKET

Municipal sewage frequently contains oil from garages and industries—in some instances in sufficient amount to interfere with fish life. In coastal waters the principal sources of oil are probably the bilge water of vessels, leaks in oil storage tanks, refineries, and uncontrolled oil wells. The oil has a twofold effect on oysters and other shellfish. It retards and interferes with the propagation of diatoms, which constitute the principal diet of many mollusks; and it reduces the rate of feeding by exerting a narcotizing effect on the ciliated epithelium. The water-soluble substances impart an oily flavor to the meat, rendering sea food from oil-polluted water unsalable; they also destroy fish spawn and fry.

SEWAGE AND SHELLFISH

When domestic sewage reaches shellfish-growing areas in sufficient concentrations and freshness, it may contaminate the bivalves with pathogenic organisms. In numerous instances shellfish so contaminated have been held responsible for the spread of disease. The most recent large epidemic of this type in the United States occurred in the winter of 1924–1925, when several hundred cases of typhoid fever in Chicago, New York, and other cities were ascribed to contaminated oysters. The wide publicity given this outbreak destroyed the market for shellfish overnight, and the Public Health Service was requested to assist in restoring public confidence in the safety of shellfish as a food. As a result of this request, the Public Health Service formulated minimum requirements for the sanitation of the shellfish industry. The various states have adopted regulations at least equal to the minimum requirements, and issue certificates good for one season only to shellfish dealers who comply with the standards. These certificates are listed by the Public Health Service as long as it has confidence in the effectiveness of the control measures of the various states, and copies of the list are supplied to state and local health authorities throughout the country. This plan has been in operation for about twelve years and has provided effective control. Municipal health authorities are usually quick to exclude from their markets shellfish not obtained from shippers on the lists of the Public Health Service.



LABORATORY IN THE EXPERIMENTAL SHELLFISH PLANT OF THE VIRGINIA STATE HEALTH DEPARTMENT, NORFOLK, VA.

Shellfish grow extensively only in protected coastal waters receiving the runoff from large rivers. These areas are definitely limited; they cannot be appreciably increased or extended. Hence, the character of the wastes discharged into streams tributary to them is of great importance. A number of these areas are now so contaminated with domestic sewage that shellfish cannot be marketed from them directly. Their existence is a constant threat to the health of consumers in our coastal states because of the surreptitious taking of shellfish from them by individual poachers.

In the vicinity of large cities discharging sewage into tidal estuaries, the damage is greatest. For example, near New York City approximately 105,400 acres of productive shellfish areas have been closed, and near Norfolk, Va., approximately 38,400 acres. Where the river carrying the sewage flows relatively long distances before it reaches the tidal estuary, as in the case of Philadelphia and Washington, D.C., less damage is done from the standpoint of sewage pollution because the river has a chance to purify itself.

Industrial wastes, on the other hand, may be harmful in high dilutions and remain potent over long periods of time. Damage may be done to shellfish areas at relatively long distances from the source of pollution and by relatively weak concentrations of wastes.

PULP AND PAPER WASTES

Fiber wastes and chemical wastes constitute the chief sources of pollution from pulp mills. The fibers eventually deposit on the bottom of streams a blanket of imponderable material which inhibits the normal growth of plant and animal life.

The bulk of waste liquors resulting from alkaline pulping processes, such as the sulfate process and the soda process, is recovered and concentrated, and the alkali is reused—though a certain amount of alkali-bearing wash water goes to the streams even when the process is functioning properly. There are occasions, however, when through accident an excess of alkali is sent to a stream to the detriment of aquatic life. Mercaptans, which are sulfur ethers or alcohols found in the cooking process in sulfate pulping operations, have a very disagreeable odor and have been found toxic to fish in concentrations as low as one part per million. They impair the nervous system of fish so that death eventually results.

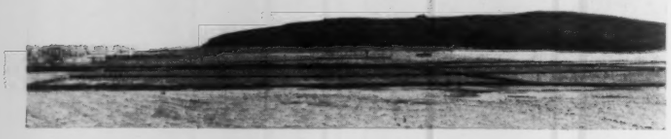
The waste liquor from sulfite processes quite readily combines with the dissolved oxygen in the stream into which it is discharged. It also has an acidifying effect

on the water and may introduce compounds of a toxic character, such as the lignin salts.

STUDIES OF PULP MILL WASTES

Several detailed studies of the effects of pulp mill wastes on oysters have been made—among them one in Puget Sound at Oakland Bay, Washington, and another on the York River, in Virginia.

In the Puget Sound study it was found that sulfite liquor, when added to sea water in concentrations of 0.5



DIKED OYSTER BEDS IN PUGET SOUND, WASH.

to 10 parts per thousand, is decidedly unfavorable to oysters, and in the laboratory produced death in from 2 to 29 days, depending upon the concentration. (These concentrations were in the range which computations indicated existed over the areas involved.) The report that followed the investigation recommended that pulp mills using the sulfite process should totally exclude their waste liquor from waters in which oysters are grown.

On the York River the oyster industry has been declining markedly during the past two decades, according to reports. Beginning in 1916 requests were repeatedly received by the Bureau of Fisheries for an investigation to ascertain the cause, but it was not until 1935 that sufficient funds were available to establish a field laboratory to make systematic ecological observations and physiological experiments. The results indicate the existence of an environment in the upper part of the York River that is decidedly harmful to oysters; and physiological experiments yield direct evidence of the harmful effects of pulp-mill effluent on the adductor muscle, on the ciliary epithelium of the gills, and on the complex mechanisms of the oyster, reducing both the number of hours of feeding and the rate. Oysters taken from polluted areas in the York River and planted in clean waters improved markedly; glycogen content, which fairly expresses the quality of the meat, increased to normal levels. Shells were strengthened by deposition of lime, and growth was resumed.

The conclusion is reached by the Bureau of Fisheries that "the presence of pulp mill waste in the water is the cause of the failure of oysters to grow and fatten in the upper part of the river and that the elimination of pulp mill pollution is a prerequisite for the restoration of the oyster industry in the York River."

The probable effect of the discharge of large quantities of pulp mill wastes into waters tributary to shellfish-growing areas should be of great interest to the shellfish industry if effects similar to those just described are to be expected in other areas where pulp mills have recently been erected or are about to be erected—as in the Southeast.

METHODS FOR UTILIZING AND DISPOSING OF SULFITE WASTE LIQUOR

At present the paper industry is engaged in studies to discover useful by-products which can be made from pulp mill wastes, as well as methods which can be economically employed to keep objectionable wastes from streams. As a result of this research, sulfite waste liquor may eventually become an important chemical raw material, and some progress in reducing the quantity and destructiveness of sulfate wastes is apparently also being made.

Of the sulfite waste liquor, 65 per cent is fermentable. Baker's yeast is prepared by neutralizing the waste liquor, inoculating it with yeast, and allowing this to grow under carefully controlled conditions. Approximately 20,000 lb per week is being produced at one plant in Nova Scotia, and equipment to double the output has been installed. Alcohol is produced commercially in Europe by the fermentation of sulfite waste liquor, though the product so obtained cannot at present compete in this country with alcohol made from molasses.

In Washington, one pulp and paper mill sprays the waste liquor down a stack 120 ft high, concentrating it to about 50 per cent solids, and sells the product as a binder for secondary roads. Concentrated sulfite liquor also has some uses as an adhesive and forms the base for most of the linoleum cements on the market. It also can be burned in a manner similar to fuel oil, but while this is practical from the viewpoint of polution prevention, it is inefficient from the viewpoint of chemical utilization. Other products, such as tanning extracts, phenol, vanillin, and fertilizer material can be obtained by precipitation methods, it is reported.

MORE RESEARCH IS THE ANSWER

It seems logical to conclude that no private industry should be permitted to damage or destroy another existing industry by the discharge of harmful wastes. The principal cost of carrying on research work to discover profitable methods for utilizing wastes or economical methods for disposing of them harmlessly should fall upon the industry responsible for their production. It should be recognized, however, that there is a large public interest involved. The burden of caring for the wastes should not be so great as to make the cost of production prohibitive.

Research laboratories adequately financed with public funds should be able to evolve methods for recovering profitable by-products. Patent rights could then be issued to the government, making the processes available to all without the payment of royalties. It is conceivable that in this way sufficient returns to the public might accrue to fully repay the expenditure. Money spent for such work should not be considered as just another form of government spending, but as an investment for the welfare of the people, who benefit from a judicious use of the country's resources. The principal source of public funds for studying such a research problem should, perhaps, be the industries themselves, but their contributions should be supplemented by public funds from other sources.

In all fairness, the issuing of summary orders to effect abatement of stream pollution should be limited, for the time being, to those industries for the treatment of whose wastes feasible methods are now available. Also, all units of a given industry, regardless of their location, should be required to effect abatements simultaneously, so that no single plant or group of plants would enjoy an advantage over competitors.

To anyone who has noted the increased demands of the public in recent years for the effective cleaning of streams and coastal waters, it must be apparent that the time is rapidly approaching when an intelligent and comprehensive plan for dealing with the problem must be evolved. If industry and government cooperate in finding a solution, it will be easier, less costly, and less disruptive than if a thoroughly aroused public, irked by delays and subterfuge, finally insists on immediate, drastic, and precipitate action.

Ground-Water Supplies in Florida

By V. T. STRINGFIELD

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IN large part, Florida depends upon ground water for both its municipal and its private water requirements. Although the supply is abundant, there is need for carefully planning its exploitation. The accompanying article describes the water-bearing formations of the state, and concludes with a review of five complex factors that must be taken into account in their development. The full paper, of which this is an abridgment, was on the program of the Sanitary Engineering Division at the 1938 Spring Meeting of the Society.

GROUND water is one of Florida's most valuable natural resources. About 240 communities in the state have public water supplies, and fully 210 of these—including all but three of the municipalities of over 5,000 population—obtain their water from wells. In addition, several thousand flowing wells are used for irrigation of celery and other vegetable and citrus crops.

WATER-BEARING FORMATIONS

The geological formations which are exposed at the surface within the state and which yield the ground-water supplies, include the Ocala limestone and younger formations. Sedimentary rocks older than the Ocala are not of general importance because they are deeply buried and contain water that is unsatisfactory for domestic or public consumption. The principal formations that yield artesian water and many of the larger ground-water supplies of the state, mentioned in order of occurrence from bottom to top, are the Ocala limestone, the Tampa limestone, and the Hawthorn formation.

The Ocala limestone underlies all of the state; the approximate position of the top of the formation with reference to sea level may be noted in Fig. 1. (A more detailed map of the top of the Ocala in the peninsula was published on page 340 of the May 1938 issue of CIVIL ENGINEERING.) The Ocala is present at or near the surface in much of the northwestern part of the peninsula and in an area in west Florida adjacent to Alabama and Georgia. In part of these areas of outcrop it is as much as 150 ft above sea level; elsewhere it dips to more than 1,000 ft below sea level. The formation is reported to have a thickness of about 500 ft in the northern part of the state and may be somewhat thicker in the southern and western parts. Predominantly it is fairly soft and permeable. In some parts of the state it is cavernous. Channels formerly occupied by ground water but now filled with sand and clay are exposed in some of the quarries. Sink holes extending from the surface of the ground deep into the limestone are numerous where the latter is at or near the surface. Some of these are now in part filled with sand and occupied by lakes.

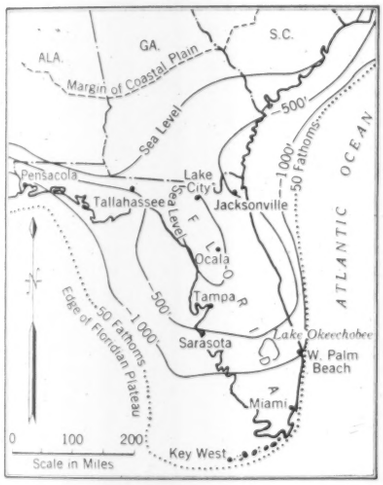

FIG. 1. GENERAL GEOLOGIC STRUCTURE, BY CONTOURS ON TOP OF THE EOCENE FORMATION

The Ocala limestone is the source of water for several thousand flowing wells, for many of the public supplies (the largest being that of Jacksonville), and for some of the large springs, including Silver Springs. The largest yield reported from a flowing well penetrating the limestone is about 7,000 gal per min.

The Tampa limestone rests upon the Ocala in the peninsula, except locally where the Suwannee limestone is present between them. The Suwannee, and several other limestones of Oligocene age, are very permeable and cavernous in certain localities, where they yield water to wells, but their thickness and areal extent are small as compared with the Tampa and Ocala formations.

The Tampa limestone is present at or near the surface in the west-central and northwestern parts of the peninsula, and in part of the area west of the Suwannee River. The formation is in general more compact and less permeable than the Ocala, and some of it is bedded. It is estimated to be in general about 200 ft thick. The Tampa limestone yields large volumes of water to wells and is the source of some of the public supplies, as those of St. Petersburg and Tallahassee, and of some of the large springs, as Wakulla Spring, near Tallahassee. One of the largest yields reported from a pumped well penetrating this formation is 5,000 gal per min.

The Hawthorn formation or its equivalent is present throughout the state except where the older rocks are exposed. It rests on the Tampa limestone, on underlying Oligocene rocks, or on the Ocala limestone, and is generally overlain by younger materials. It consists of about 500 ft of interbedded marl, limestone, sand, and clay, all of which are more or less phosphatic, and contains permeable beds, in which water is confined by less permeable beds that lie above or below them. It prevents or retards the upward escape of the artesian water in the Tampa and Ocala limestones.

Usually wells in this formation have only moderate yields; where large supplies are required the wells are drilled into the underlying limestones. The rocks overlying the Hawthorn formation, and the surficial sands, supply water to many wells for domestic use and also wells for large public supplies, as at Miami and Pensacola, where the deeper waters are unsatisfactory.

SOURCE AND MOVEMENTS OF ARTESIAN WATER

In Florida the source and movement of water in the surficial formations are in general more local than the source and movement of water in the underlying artesian limestones. Water that enters the artesian formations may travel long distances before reaching an exit through wells. However, the chief source of the artesian water is probably the rainfall within the state itself and the southern parts of Georgia and Alabama.

With proper interpretation, information concerning the general source of the water and the direction of its movement can be obtained from an accurate contour map

of the piezometric surface—that is, the surface showing the height to which water will rise above sea level in tightly cased wells penetrating the artesian formation (Fig. 2).

The "Polk County area," in the central part of the peninsula, is one of the largest and most conspicuous features of the piezometric surface. It has the shape of an elongated dome, part of which is 90 to 120 ft above sea level. This high area indicates local recharge of the water-bearing formation and lateral movement of the water in all directions therefrom. Since in this region the Ocala and Tampa limestones are overlain by relatively impervious members of the Hawthorn formation, it might appear that little or no ground-water recharge would take place. However, numerous lakes occupying old sink holes now largely filled with permeable sands permit a downward percolation of water to the underlying limestone. Water from the lake region of central Florida therefore supplies much of the artesian water in central and southern Florida.

Another large high area of the piezometric surface, called the "Putnam County area," is located to the north of the Polk County area. It forms a ridge which extends into Georgia. In the southerly parts of this area recharge takes place through sink holes or through the formations exposed at the surface, and water is also supplied through a recharge area in Georgia.

The saddle between the Polk County and Putnam County areas is also in part a recharge area. However, here there is free discharge of ground water through large springs. Along parts of the east and west coasts where the Ocala limestone is at or near the surface, there are low areas of the piezometric surface which reveal large discharge; and there is also a large discharge area in the valley of the St. Johns River.

In areas where the piezometric surface is higher than the land surface, flowing wells can be obtained. These areas comprise more than one quarter of the total land area, and include the Atlantic coast, southern Florida, and the Gulf coast. Wells that are supplied from the artesian formations range in depth from less than 100 ft to more than 1,000 ft and in yield from a few gallons to several thousand gallons a minute.

GROUND-WATER PROBLEMS

Although there are large supplies of ground water in Florida, there are many complex problems, both quantitative and qualitative, most of which relate to the safe yield. They include: (1) decline in head and yield of wells in areas of large draft from wells; (2) subsurface leakage out of wells; (3) surface drainage by means of wells; (4) contamination of fresh ground water by salt water; and (5) the occurrence of ground water containing objectionable amounts of fluoride.

The largest decline in head and yield of wells in areas of large draft from wells has been noted in Jacksonville and Panama City. There it appears that the artesian head has declined as much as 30 ft. As an illustration of the decline in yield, it may be noted that the initial natural flow of a 10-in. well constructed in Jacksonville in 1889 was about 600 gal per min, but in 1937 the natural flow of this well was only a little more than 100 gal per min. In order to determine the safe yield, where large supplies are being withdrawn from wells each year, it is obviously important to obtain reliable information concerning both the amount of water withdrawn and the amount supplied to the formations by annual replenishment.

In connection with subsurface leakage, it is significant that only a few of the artesian wells in the peninsula are completely cased and in many of them the uncased parts extend through water-bearing beds at several horizons. Under such conditions water entering the well from beds with relatively high pressure may escape into beds with lower pressure instead of rising to the surface or remaining confined in the well. In certain parts of the state

FIG. 2. MAP REPRESENTING THE PIEZOMETRIC SURFACE OF ARTESIAN WATER IN THE PRINCIPAL ARTESIAN FORMATIONS IN FLORIDA

such underground leakage is known to occur, and it will doubtless occur in other parts if wells are not properly cased.

The third problem, that of drainage wells, is present in some parts of the lake region and other localities where surface drainage is poor. In these localities, where the water level in wells is several feet below the surface, surface water is drained into wells constructed for that purpose; and some of them penetrate the Ocala limestone. In addition to the sanitary problem thus created, there is also the question of the capacity of the well and of the water-bearing formation.

The fourth problem, that of contamination of fresh ground water by salt water, is of importance along parts of the coast and in certain inland localities, where some of the wells yield water with a chloride content of more than 100 ppm. The water-bearing formations are exposed to salt water on the ocean floor and at the edge of the Floridian plateau. In several parts of these coastal areas the artesian pressure is sufficient to cause the fresh water to discharge through submarine seepages or springs and no encroachment of sea water is now occurring. It may occur, however, if a sufficient lowering of fresh-water pressure takes place; and it has already occurred in several localities, contaminating a number of fresh-water supplies, including those formerly used by Tampa and St. Petersburg.

The fifth of the ground-water problems is that of fluoride content, which is objectionably high in some localities. It appears that these waters are from the Hawthorn formation, which contains phosphatic material.

In conclusion, it is evident that although there is a general abundance of ground water in Florida, there is nevertheless a need for careful planning of its development and conservation. The solution to the various problems requires the combined efforts of engineers, geologists, chemists, and other investigators, and the cooperation of the drillers and owners of wells.

Sewerage Problems of Miami, Fla.

Flatness of Terrain and Nature of Underlying Rock Make Disposal Difficult and Expensive

By C. S. Nichols

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TO THE sanitary engineer, the city of Miami presents a variety of interesting problems. Much of its area is but four feet above sea level. The porous limestone underlying the surface requires special excavating machinery, and gives up its water so readily that sewer construction costs are high. The city has grown so rapidly that an integrated sewerage system is yet to be developed, and plans for it are complicated by unusual restrictions on the location of the treatment plant. The accompanying article is abridged from a paper presented before the Sanitary Engineering Division at the Society's 1938 Spring Meeting in Jacksonville.

MIAMI is a coastal city in almost every sense of the word, though it is separated from the sea by a bay three miles wide, and by the city of Miami Beach and certain keys which are directly on the Atlantic Ocean. Miami is not typical of anything; in fact, it is in so many ways unique that it offers many engineering problems not encountered elsewhere.

The intensity of rainfall, coupled with the flatness of the territory, creates a considerable problem in surface drainage. The city area averages approximately 8.0 ft above mean low tide, a considerable portion being as low as $3^1/_2$ to 4 ft, and the normal tidal range at certain seasons is about 36 in. Under such conditions the flow capacity of a storm sewer must depend upon the hydraulic gradient established by the difference in elevation between, say, the curb and the water surface at the outlet when the tide is at its highest. For many sections this gradient is very flat indeed, and local flooding is bound to occur frequently unless pumping is resorted to. As yet, there has not been sufficient popular demand to justify the introduction of the expensive process of pumping storm water, just to prevent a limited amount of inconvenience. We do have storm-sewer pumping stations, however, in sections where gravity discharge is not available.

In areas where storm sewers are not available, but where subdividers have insisted on trapping surface water by building curbs, we have resorted to various methods. Trenches dug into the porous rock and covered with a concrete or other suitable slab, are quite effective. Pits dug into porous rock and filled with boulders also operate satisfactorily for a time, until silt gradually fills the voids. Drainage wells from 8 to 18 in. in diameter, drilled to salt-water-bearing materials, have been very beneficial. Often one well will serve several blocks in each direction if inverted siphons are built at corners so that the water can reach the inlet. All such devices are, of course, inferior to free-flowing storm sewers, but they do remove the water in a few hours.

Our 146 drainage wells are of varying depths, from 65 to 300 ft, and average about 125 ft. Most of them, by requirement of the State Board of Health, are founded in salt water—but the probability of finding salt water at any given location is very uncertain. It seems to occur in uncharted geological fingers, with no assured continuity in direction or capacity. A maintenance force cleans these wells regularly by "blowing them out." This operation consists of lowering a hose and air point to the bottom and turning on a large volume of air at high pressure. Blowing is continued until the well has been thoroughly cleaned and the dirt collected outside.

In sewerage facilities as in all other undertakings, Miami is exceedingly young. Incorporated in 1896 with barely 300 people, the city has grown in 42 years to an estimated population of 150,000. Few cities have had such a record of growth and it is probably well that they have not. It results in much confusion in municipal development. Of necessity the cart has many times been squarely in front of the horse, and much work of an exceedingly temporary nature had to be done before permanent plans could be made or finances provided.

The first small piece of sanitary sewer was constructed in 1915, starting at the Miami River and extending back at a very flat grade for about two blocks, particularly to serve certain business houses which did not have sufficient area for septic tanks and drainage fields on their own grounds. From then until 1930 the construction of sewers progressed rapidly until in the latter year there were approximately 210 miles of sanitary sewers, 36 miles of storm sewers, 16 sewage pumping stations, 146 drainage wells, and many other drainage structures. And even so not over one-fourth of the city is provided with sewers.

Until 1925 the land area of Miami did not exceed eight square miles, most of it of such nature that septic tanks and drainage fields did a fairly good job of unit sewage treatment. With about 75,000 population and 200 miles of streets, the town then boasted about 100 miles of sewers. This did not mean that it was half sewered, as many streets carried parallel sewer lines on opposite sides of the street purposely to conserve depth. In every case the sewer had been started at the river or at the bay and run flat as far as it would go, and that was all.

Suddenly in 1925 an annexation election resulted in the addition of about 50,000 people, 35 square miles of land area, and 650 miles of streets. For most of this new territory there were no municipal improvements of any kind except some roadway surfacing. But the moment it was annexed, its residents started to make demands for service and improvements. Within three years we designed and built 12 miles of large storm sewers, 110 miles of sanitary sewers, 12 sewage pumping stations, 140 drainage wells, and many other drainage facilities.

DIFFICULTIES OF SUBSURFACE CONSTRUCTION

Among other things, it became necessary to redesign all the sewers in the business district, both storm and sanitary. In gathering field data for the design, it was early found that former installations of underground structures, without adequate plans, permits, supervision, and records, had so obstructed the streets underground that a design for positive location and clearance of obstructions was impossible. So there was created an active "underground organization" to survey what existed and to pass definitely on all new underground installations. So far as possible, we zoned the street and held

certain portions, both vertical and horizontal, for particular types of installations. This has proved very beneficial to all concerned, and now we can route sewers and other utilities with reasonable assurance of finding complete clearance when the ditch is opened.

The material to be excavated is generally a limestone rock, usually porous, and sometimes exceedingly hard and difficult to handle. If hand removal is employed, progress is slow and expensive. Air cutting tools assist materially, but the usual method, where underground structures will permit, is to use a wheel-type trenching machine, heavily built and specially designed for the purpose. For wide ditches, double cutting is employed, either by leaving a narrow ledge between cuts, later removed, or by back-filling the first cut and making another one immediately adjacent, and then cleaning out by hand or with shovel equipment. Ladder machines have proved ineffective, except for narrow and shallow cuts.

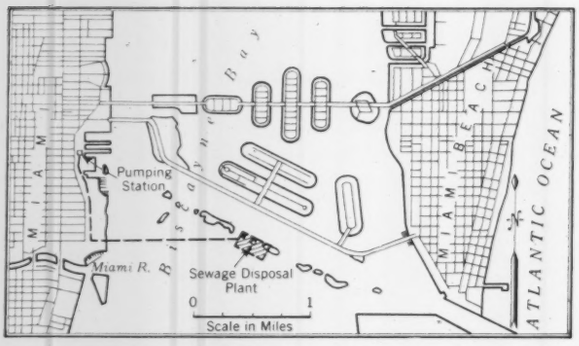

FIG. 1. SKETCH MAP SHOWING PART OF DOWNTOWN MIAMI, SOUTHERN TIP OF MIAMI BEACH, AND PROPOSED LOCATION OF PUMPING AND SEWAGE-TREATMENT PLANTS

In sewer construction, ground water is a real problem. The level varies from an exceptional low of plus 1.5 ft all the way to a full ground reservoir, running over to flood the low areas during periods of long-sustained and heavy rainfall. The porous limestone rock gives up its water so readily that pumping is necessary at an early stage in sewer construction. This adds to the expense of dry construction, and increases the cost rapidly below zero elevation. Outside contractors generally get a few surprises on their first sewer contracts in the Miami area unless they are humble enough to accept information from the local people. Well points are totally inadequate, except for shallow depths and special locations. When sewer construction is attempted below zero elevation, it is well to use large pumps and to dewater one short section at a time.

Water and tide conditions often cause flotation of pipe lines and sewer appurtenances. The tidal range is decidedly noticeable over the whole area. Many a contractor has to see a cast-iron pipe line float, or a manhole or concrete pump station pop up out of the ground to appreciate the strength of water uplift. Often our attempts to aid contractors with advice about such things are misinterpreted as efforts to dictate construction methods.

As yet we have experienced no trouble with disintegration of concrete in sewerage structures. However, we have a problem with sewer joints. Our ground water is a seaward flow from the Everglades, and is laden with tannic acid and other active agents of vegetable decomposition. It has attacked and quickly destroyed all the flexible joint materials—cold, premolded, and hot poured—that we have tried so far. This is a serious difficulty, as a large mileage of sewers is submerged in ground water and a large part of the sewage must be pumped, some of it twice. Rigid joints, when used throughout, are definitely a failure. The sewers are laid in open ditches and are therefore jointed at maximum elongation. When they are covered, the drop in temperature causes a shortening of the line, and if all the joints are rigid and stronger than the pipe section, the pipe breaks just behind the bell, and the wyes often snap off. We are now carrying on experiments by which we hope to discover a type of flexible joint that will serve our purpose. If this effort fails, and possibly anyway, we will adopt metal pipes for under-water sewer construction, with watertight metal joints.

In most cities it is possible to find, somewhere along the water courses or waterfront, just the proper location for a sewage treatment plant, with assurance that its operation will not affect anyone adversely. But not so in Miami. The waterfront is the front yard, and the possibility of concentrating or treating sewage there is unthinkable. This introduces a decided complication.

It has been suggested that the large volumes of water in the Miami River and in Biscayne Bay should be able to handle satisfactorily, just as it comes, all the sewage from the various greater Miami communities. But while the Miami River is quite deep, most of its depth is composed of salt water; consequently the fresh-water discharge from the sewers rises quickly to the surface and spreads an unsightly mess over large areas. The same thing occurs in the bay. Both of these bodies of water are used extensively for boating and should be free from floating sewage. This cannot be assured until a collection system is installed which will intercept all the sewage outlets along the shores of the river and bay and transport the sewage to some other area for disposal or treatment.

Even though the initial cost of sewage treatment works is high, the expenditure is warranted. Unfortunately, while the city of Miami has legislative authority to make a charge for sewage disposal service, it has no authority to make such charge or lien against the property benefited. As a result, financiers have been hesitant to invest large sums in a disposal project. Quite evidently, the proper legislation is almost a prerequisite to the financing of any such development.

PROPOSED PLAN FOR SEWAGE DISPOSAL

It will be necessary to intercept all of the nearly 70 outfall sewers discharging into the Miami River and into Biscayne Bay, and pump the sewage either out to the Gulf Stream (7 or 8 miles away) or to a treatment plant far removed from habitation, where all solids and floating materials will be removed, and where the clarified liquid can be discharged into the large volume of bay water far from shore. Because of the long shore lines of both the river and the bay, a considerable mileage of large-diameter intercepting sewers will be required.

Under present plans the intercepters would concentrate at a pumping station near the bay front, whence the sewage would be conveyed to a treatment plant on an artificial island in the bay at such distance from all habitation as to insure safety against any nuisance (Fig. 1). The entire island (which, as proposed, would be about 1,400 ft long and 700 ft wide) would be grassed and landscaped to make it as nearly as possible a park, to which visitors would be invited. The plant would be designed for an immediate capacity of 50 mgd, with provisions for future expansion as needed.

Whatever method of disposal is adopted, it is expected that the project will cost at least five million dollars. A like sum should be available immediately for sewer extensions and other sewerage facilities. Thus it would appear that our problems are largely ahead of us—and we are hoping eagerly for the opportunity to solve them.

Protecting Galveston Beach

History of Protective Works Reviewed at Joint Session of American Shore and Beach Preservation Association and Society's Waterways Division at 1938 Spring Meeting

By C. C. WASHINGTON
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COUNTY ENGINEER AND COUNTY SURVEYOR, GALVESTON COUNTY, GALVESTON, TEX.

GALVESTON Island is one of a series of low sand islands on the Gulf of Mexico, separated from the mainland of Texas by shallow bays. The average tidal variation in the Gulf is 2 ft; and the predominating littoral drift is from west to east, though it frequently reverses its direction.

From Thirteenth Street, in the city of Galveston (Fig. 1), to Fifty-Third Street the beach is very narrow and is frequently covered by the tide. Beyond these limits in each direction, the ordinary width of the beach is 300 to 400 ft. The sand on the beach and extending into the Gulf waters is very fine, will move when dry in winds of 10 to 12 miles per hour, goes into suspension easily, and is readily transported. When damp it becomes hard, packed, and smooth, and affords a remarkably good riding surface. The beach has a very slight slope—about 1 ft in 100 ft—and the same general slope continues into the water, making an ideal bathing beach.

COMMENCING WORK ON GROIN NO. 2 AT GALVESTON

Offshore, there are bars parallel to the shore, about 200 ft apart, with channels about 2 ft deeper between them. The number and the position of these bars constantly change, but usually there are three or four, the first one being 200 ft offshore. At times no bars are present; changes are rapid.

The island is subject to tropical hurricanes of high violence, producing winds up to more than 125 miles per hr and tides as high as 14 ft. Usually after a storm, a bar is formed above water about 300 ft out, with a deeper channel than ordinary just offshore. In seven to ten days this bar becomes lowered, the excess material moving inshore. While there has always been an apparent increase in erosion during storms, a far larger amount has resulted from the action of normal sea currents.

Prior to the building of jetties (1887–1910), the natural pass at the east end of Galveston Island was about double its present width. The island jetty extends today $2^1/_2$ miles into the Gulf from shore, but when built it began on the bay side at Sixth Street, ran northeast to a low tidal sand island, and extended thence $4^1/_4$ miles easterly into the Gulf. Since then, as a result of the jetty action, a triangular area 3 miles long and $1^1/_2$ miles wide has filled on the Gulf side from an average depth of $6^1/_4$ ft to an average height above mean low tide of $3^1/_4$ ft—a total fill of $9^1/_2$ ft. A large amount of filling has also occurred between the jetties near the present island shore. In all, nearly 25,000,000 yd of sand eroded from the west has been moved into this area. A differently planned jetty might have produced less erosion, but it is doubtful whether any more successful plan for increasing depth over the Galveston bar could have been evolved.

From 1838 to 1850 decided erosion took place at the east end of the island, and from 1850 to 1893, erosion was very marked from a point about 2 miles from the east end of the island to Twenty-Third Street. In 1890, H. T. Wilson, city engineer of Galveston, reported to a "beach committee" that over 100 acres of beach frontage had been lost between Fourth Street and Twenty-Fourth Street; he attributed the loss to the construction of the south jetty and recommended a series of groins at right angles to the shore, extending seaward 300 ft.

In 1892, the city of Galveston built three groins as recommended, at Sixth Street, Thirteenth Street, and Seventeenth Street, and a little later a similar groin at Ninth Street. They were well built and still exist, but have been buffeted by numerous storms, with no repair, and becoming flanked at the shore end, their effectiveness has been impaired. The one at Sixth Street is entirely covered by accretion caused by the jetties.

No accurate measurements have ever been made to show the amount of erosion that has occurred west of the Galveston city limits, but it is well known that the shore line has moved back considerably—on the average about 300 ft.

The Galveston sea wall, from Sixth Street to Fifty-Third Street, was constructed between 1902 and 1904. (A cross-section is shown in Fig. 2.) The wall has since been extended in both directions, and is now continuous from the south jetty to west of the city limits.

In 1909, the Gulf had encroached practically to the foot of the sea wall riprap, and the Commissioner's Court of Galveston County requested General Robert to make a recommendation in regard to erosion protection. He recommended construction of rock groins starting at the foot of the sea wall and extending out into the Gulf 300 ft, and not over 900 ft apart. He also recommended that the existing groins be repaired and connected to the sea wall.

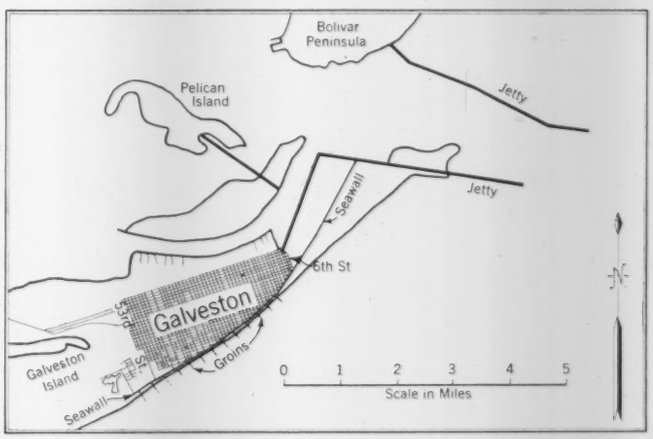
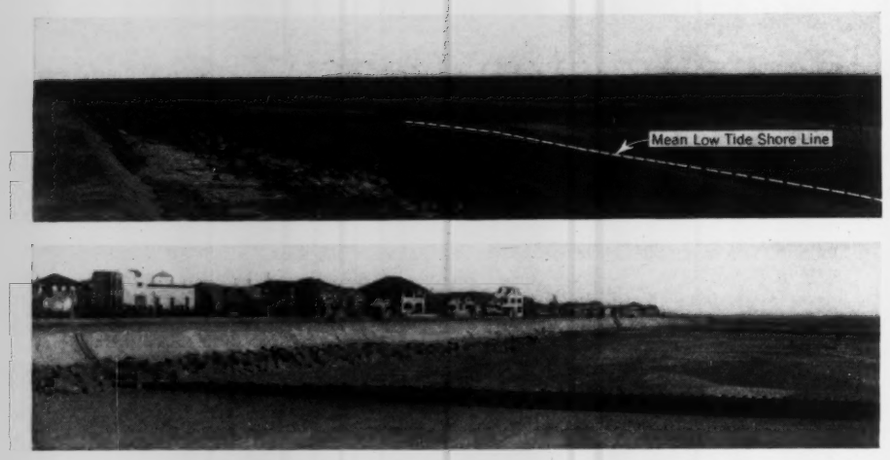


FIG. 1. EASTERLY END OF GALVESTON ISLAND, SHOWING JETTIES, SEA WALL, AND GROINS



WITH THE NEW GROINS IN PLACE, THE RISK OF DAMAGE TO THE SEA WALL HAS BEEN AVERTED

His recommendations were not followed. A short time thereafter the city of Galveston constructed some 32 small wooden groins between Eighth Street and Thirty-Ninth Street, but they were not joined to the sea wall nor were they built sufficiently low, and they were soon flanked at the shore end, undermined along the foundation, and buffeted to pieces by the waves so as to be of no value. What remained of the construction was removed, as it was unsightly and a menace to bathers.

In 1922 a wooden-pile open groin, with piles about 18 in. apart, was constructed at Twenty-Fourth Street. It projected about 400 ft into the Gulf. The construction was experimental only, the theory being that the piles would retard the shore currents, yet allow them to pass through. This groin accomplished all that was expected of it. It built up a beach about 20 ft in width and 400 ft long, and also produced considerable under-water fill.

By 1933 it was apparent to everyone that unless something was done the sea wall and the boulevard behind it would be endangered. A channel 4 to 5 ft in depth had formed, with its center 115 to 165 ft out from the toe of the riprap of the sea wall, and ordinary tidewater was 2 to 3 ft deep at the toe of the riprap. Application was made to the Beach Erosion Board, and the Board, after study, recommended the construction of groins. The basis of design (Fig. 2) was as follows:

"The height of the shore section of the groin . . . should be sufficient to impound sand at the toe of the sea wall but not high enough to prevent the free passage of sand at the normal berm elevation, which is approximately 5 ft. Hence, the elevation of plus 4 has been selected as proper. The citizens of Galveston desire a beach approximately 300 ft wide. To provide this, the length of the shore section has been fixed at 100 ft and the sloping section has been given a slope of 1 on 66 and will extend 200 ft beyond the shore section. The top of the offshore horizontal section will be at elevation plus 1 and should extend for 200 ft, making the total length of the groin 500 ft. These groins should be spaced 1,500 ft apart and should be generally perpendicular to the face of the sea wall. The shore ends should be firmly attached to the sea wall to prevent flanking and to prevent scour at the toe of the wall during storms."

This recommendation was acted upon and the government began construction of the groins. To date ten have been built, at a cost of about $23,000 each. They are sturdy structures and in this short time have demonstrated their value. There is no doubt that a large amount of material has been deposited along the sea wall riprap and that the sea wall will be sufficiently protected when the project is completed. It is doubtful whether this construction alone will be sufficient to secure a beach of the proper width for a driveway, but probably the needed width could be achieved by pumping sand into the Gulf west of the last groin, as suggested by the Beach Erosion Board. The sand for this operation would have to come from some source well removed from that part of the shore which it is desired to build up.

If such a system, or a similar system, of groins had been built at the same time as the sea wall, there can be little doubt that the entire beach as it then existed would have been saved, and at a cost of not over $200,000. It does seem strange that so many years should have been required to complete the solution, so nearly completed in 1892 by Mr. Wilson, and again recommended in 1909 by General Robert. The delay can only be explained by public apathy to the value of the remarkably fine natural driveway and playground immediately in front of the city.

Photographs and plans used in this article were obtained through the courtesy of the U. S. Corps of Engineers, Galveston, Tex.

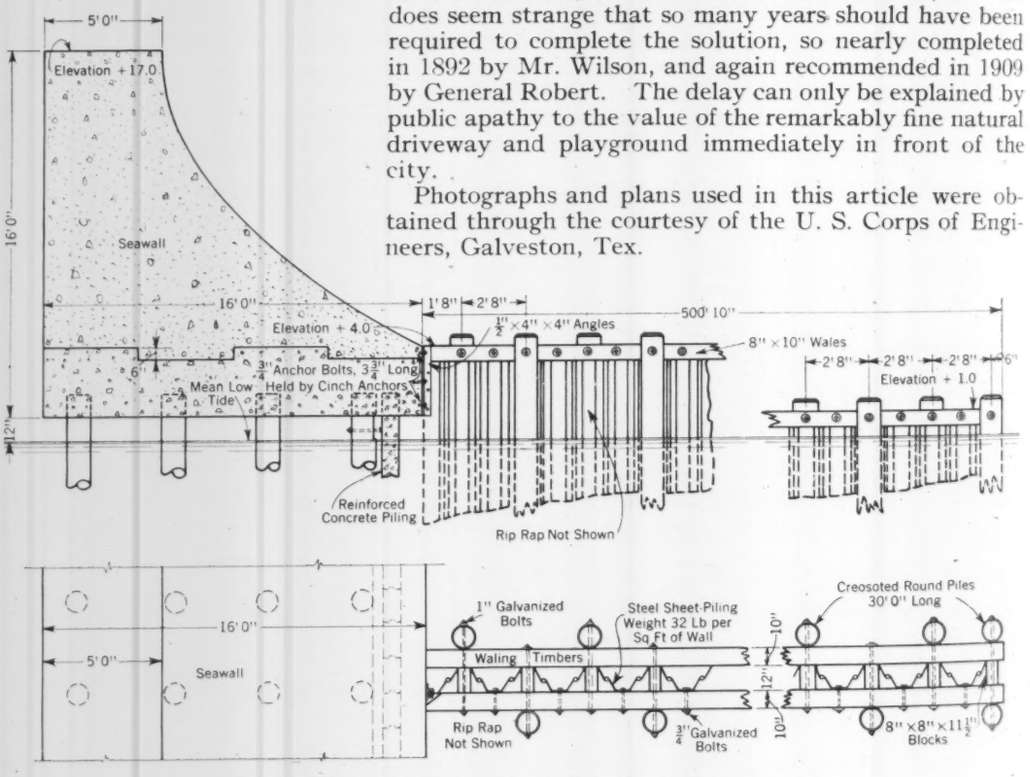


FIG. 2. SECTION AND PLAN OF SEA WALL AND NEW GROINS
Note Provision for Connecting Groin to Wall

California Beaches

A Non-Technical Review of Progress and Problems in Beach Preservation—from a Paper Presented at the 1938 Spring Meeting of the Society

By GEORGE HJELTE

SUPERINTENDENT, DEPARTMENT OF PLAYGROUND AND RECREATION, CITY OF LOS ANGELES, CALIF.

YACHT HARBOR AND PROTECTIVE BREAKWATER AT SANTA BARBARA

ABOUT eight years ago, at a meeting of the American Shore and Beach Preservation Association, I presented a paper outlining the problems of beach preservation confronting the state of California and its seashore cities and counties. Now, surveying the developments of the past eight years, I am impressed with the progress that has been made. Despite the economic depression, California has steadfastly continued its efforts to preserve and protect its long and scenic shore.

In my earlier paper I stated that the paramount problem was that of acquiring public ownership of a substantial part of the most scenic and most useful foreshore or upland adjacent to the ocean. Since 1928, approximately 60 miles of waterfront land has been purchased by various agencies in the state. The most notable accomplishments in this regard have been those of the State Park Commission, which has acquired and improved 26 waterfront areas totaling 7,288 acres. These purchases were made possible by the passage, by popular vote in 1928, of a measure providing for a $6,000,000 state bond issue and for the matching of that sum, dollar for dollar, by local jurisdictions.

The county of Los Angeles, the city of Los Angeles, and the city of Long Beach have also done their share in acquiring public beaches near the southern metropolitan center. Two miles of beach were purchased by the city and county of Los Angeles in the famous Malibu and Santa Monica Bay region, and the county and the city of Long Beach have made notable purchases in the El Cerritos Bay section.

In the southern part of the state, beach protection and reclamation have been no less important than beach acquisition. Long stretches of splendid bathing beach have been created by groining and dredging at Santa Barbara, Los Angeles, Santa Monica, Newport-Balboa, and Huntington Beach. Increased interest in yachting has justified the construction and improvement of yacht harbors. To provide better facilities for this sport the city of Newport, with the aid of federal funds, expended over five million dollars. Breakwaters were built at Santa Monica and Santa Barbara to shelter small craft. These structures, while of benefit to yachting, have created a serious problem by interrupting the littoral drift of sand, and this problem has not yet been solved completely. The silting up of the harbors has indicated the necessity for dredging, and steps to begin such work have already been taken by both cities. Beaches to the leeward of these harbor breakwaters have begun to suffer considerably from the loss of sand which they ordinarily would receive but which is being trapped within the still waters created by these barriers. Erosion has therefore become a major concern of public beach authorities, and steps to protect ocean frontage through systems of groins are now receiving serious consideration.

CABRILLO BEACH—A MAN-MADE PLAYGROUND OF 26 ACRES

Berkeley also has completed a satisfactory harbor for small craft in San Francisco Bay, and Los Angeles has constructed two artificial beaches—at Playa del Rey and at Cabrillo Beach, San Pedro.

In the past eight years the various governmental agencies of California have spent about $10,000,000 on beach and yacht harbor improvements, and for beach acquisition about $6,000,000. These sums do not include expenditures for commercial harbors or federal funds contributed to yacht harbor construction.

In connection with beach development, a number of scenic highways have been constructed or proposed. Of particular interest is the contemplated extension of the Roosevelt Highway through Santa Monica and Venice. This road is planned to parallel the ocean front and to be laid on a sand fill over a distance of about 12 miles. The fill will be of sufficient width to provide a beach between the highway and the water's edge, and will be held in place by groins at 1,500-ft intervals. Sand is available in the nearby hills, and it can easily be transported by hydraulic methods. The cost would be about $6,000,000.

In 1930 oil was discovered in Venice, and before the hysteria had subsided, derricks had been erected along two miles of splendid bathing beach—on private property to be sure, but so close to the water as to spoil the adjacent beaches for recreational use. Later a similar development took place at Huntington Beach. The resulting damage to the beaches is irreparable.

The possibility of economic gain by the state from leasing of tidelands to oil operating companies raised an interesting issue in California. Should the state exploit its tidelands for oil and derive some hundreds of thousands of dollars in annual revenue, or should it preserve its beaches from the encroachment of oil wells and save them for recreation? A constitutional amendment which threatened to open up the entire shore for drilling operations was defeated in a general election held in 1936. In 1938 a more moderate measure was passed by the legislature, the full effect of which it is too early to predict.

The controversy over the defeated amendment has continued, and has served a worth-while educational purpose in making the public more conscious of the necessity for beach protection. It is to be hoped that California will appreciate its natural advantages and give its beaches the protection they merit.

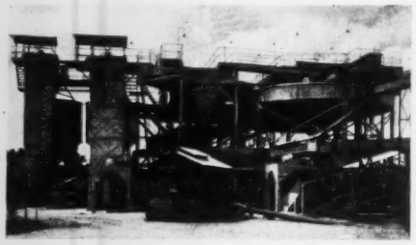
Development of Florida's Phosphate Industry

Paper Presented at Society's 1938 Spring Meeting Tells of Important Rôle of Engineers in Reducing Cost of Output from World's Largest Producing Area

By H. D. MENDENHALL
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, TALLAHASSEE, FLA.

JUST 50 years ago (1888) two incidents occurred that changed the destiny of Florida. George W. Scott, of Atlanta, while drifting down the Peace River, attempted to tie his boat to a projecting root, only to find that the root was the tusk of a prehistoric animal. In Dunnellon, Albertus Bogt, while sinking a well on his premises, observed some fossil teeth in a white subsoil.

The first incident led to the discovery of the river pebble, and the second to the hard rock phosphate deposits of the state—incidents that started the development of the industry that now ranks seventh among its wealth-producing activities. In this 50-year period it has brought in over $270,000,000 of mineral wealth and created employment for countless thousands of men. Florida now produces 80 per cent of the phosphate of the world.



A MODERN PHOSPHATE WASHING PLANT

The Florida deposits are of two general types. The hard-rock deposits, found along the Gulf side of the peninsula from Suwannee and Columbia counties on the north to Citrus and Hernando counties on the south, lie in pockets of irregular occurrence and are derived from a stratum of phosphatic marl. The pebble deposits, found in Hillsboro, Polk, and Hardee counties, are a conglomerate of pebble, sand, and clay.

Actual mining of phosphate began in 1888 in the river pebble deposits. The high market price—about $20 per ton—and the ease of mining, made possible the profitable conduct of the infant industry. Crude floating dipper dredges were used, the matrix being washed on the dredge barge and the rock transferred to land by various means. Drying was accomplished by building up a mat of pine and oak logs several feet thick, dumping washed rock on it, and setting fire to the mass. A large open shed covered the entire pile. These "kilns" would smoulder for weeks and in the end the rock would be sufficiently dry to ship.

THE EARLY DAYS OF THE INDUSTRY

By 1890 there were two mining plants in the pebble district—both in Polk County. A pebble mining plant then consisted of a floating dredge similar to those used for river mining, a drying shed, the necessary railroad tracks, and miscellaneous shops and quarters. It is probable that the total cost of such a plant, exclusive of the price of the land and the railroad, would not exceed $10,000. The overburden was moved principally with mules and scrapers or even by man power. All mechanical power was derived from steam engines with wood-burning boilers.

By 1892 Florida was alive with phosphate mines. Within the two years preceding, steam shovels had made their appearance and in the pebble district hydraulic mining was beginning to appear. Experiments with floating suction dredges were being made in the hard-rock district to extract the rock lying below the ground-water level, but with such indifferent success that they were finally discontinued.

In the hard-rock district complex washing equipment was beginning to appear. The rock, originally transported directly to the kilns by wheelbarrows, was now loaded into 1-yd cars running on wooden tracks and hauled by cable to the top of the washer along an inclined wooden trestle. There the rock was run by gravity through grids, crushers, and screens and over picking tables until it emerged at the lower end cleansed of everything but the impurities combined within the rock itself. Its period on the dry kilns, already described, prepared it for shipment.

As is characteristic of all industries showing early speculative profits, no engineers, as such, had appeared in either district. The erection of the mining structures was done by mechanics, carpenters, and others, with practically no more preliminary design than could be done by smoothing out a clean place on the ground and marking out the plan on it with a sharp stick. Prospecting was conducted largely by agents of various chemists.

By 1900, the industry, both in the hard-rock and pebble districts, had become fairly well stabilized. The small "skin-pole" plants had largely disappeared either through bankruptcy or absorption by larger companies. Mining equipment had become well standardized, marketing facilities had been greatly improved, and prospecting put on a dependable basis. However, a far-reaching change was coming over the industry as a result of the discovery of high-grade rock in the pebble deposits. Up to that time practically all the high-grade rock—analyzing 74 to 77 per cent bone phosphate of lime—had come from the hard-rock district. The pebble deposits, analyzing 64 to 70 per cent, did not meet the requirements of the foreign markets. These latter, particularly Germany and Belgium, demanded rock high in bone phosphate of lime and low in iron and aluminum, and the hard-rock deposits of Florida were practically the only ones known which met that requirement. But the discovery of cheaply obtainable pebble rock of high grade brought a serious competitor to the hard-rock district and ultimately relegated it to second place.

The continuity and extent of the pebble deposits prompted the introduction of large-scale operations. Electric power with central power stations began to replace steam engines. Steam shovels were universally used for removing overburden, and hydraulic monitors were used almost exclusively for mining the rock. The old floating dredges disappeared and the washing was done entirely on land.

Up to this point, however, engineers as such still had not entered the field. Any improvements made had come through the hard school of trial and error—mostly

error. Such was the situation in 1905, when the writer became the first engineer in the pebble district to devote his time exclusively to phosphate mining designs.

From 1905 to 1910 a number of new companies entered the pebble field, offsetting the complete discontinuance of river mining in 1908. Simultaneously the great fertilizer and chemical companies, who hitherto had bought their rock from independent companies, now began to enter the field on their own account, either by purchasing existing plants or erecting their own.

Since 1910 there has been considerable expansion and consolidation. In 1911, 17 companies operating in the pebble district produced a little over 2,000,000 long tons of phosphates; in 1929, there were 7 companies with a total annual output in excess of 3,000,000 long tons.

In the hard-rock field the movement has been retrogressive, mainly because of inability to compete with the high-grade deposits developed in the pebble field. Whereas there were 43 companies mining in 1911, producing a total of 474,094 long tons, in 1929 there were only 5, producing 72,424 tons.

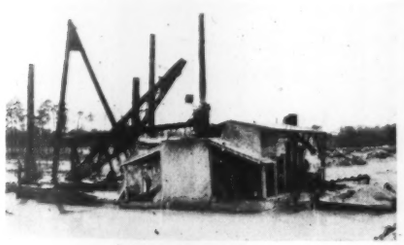
TRAINED ENGINEERS ENTER THE FIELD

The advent of trained engineers into the mining field began an era of stabilization. Systematically planned schedules were introduced, mining and prospecting methods were perfected, and the conditions under which labor lived and worked were improved. Then, in the years following the World War, the engineers turned their minds to new processes and ideas.

Probably the most startling innovation was the successful development in 1928 of the oil flotation process for recovering phosphatic screenings. It is now used by a majority of the pebble mines. Briefly, the process consists of treating waste screenings with an emulsion of crude oil and sodium oleate, the compound adhering to the phosphate but not to the silica, causing the former to float and permitting an easy separation on the flotation tables. Previous to the development of this process, it is conservatively estimated that as much high-grade rock was wasted through the screens as was saved for marketing. With the new process it is now estimated that practically 95 per cent of the rock in the matrix is saved.

Probably the next greatest improvement made by engineers has been in the method of removing overburden. In 1920 the use of large-capacity drag-line excavators was initiated on a large scale. The first draglines had 136-ft booms (the largest built at that time) with 8-yd buckets, and used Diesel engines. Since then the size has been increased to 168-ft booms with 10-yd buckets, and they are now electrically operated.

These behemoths, now generally used throughout the pebble district, gnaw out a ditch about 210 ft wide and handle about 600 cu yd per hour, operating in three 8-hour shifts, three men per shift. The hydraulic mining follows closely on their heels so that, by hauling back to the starting point, the draglines can place the excavated material from the second cut in the mined-out area of the first, thus practically covering up their own tracks.



DREDGE AND WASHER OF THE 1890'S

The savings effected by the new method are worth mentioning. Excavation by hand (as in the early days of the industry) cost from 15 to 25 cents per cu yd. Mules and scrapers could usually be contracted for at from 12 to 15 cents per cu yd. According to figures compiled by Charles A. Fulton, president of the Southern Phosphate Corporation, the average cost for a yard by hydraulic methods was 12 cents. And the same authority gives the average at one mine for earth moved by the giant draglines as 1.8 cents. When it is realized that it requires the removal of from 8 to 10 cu yd of overburden for a ton of rock, it is obvious that the saving from overburden removal alone amounts to a substantial figure.

MODERN PHOSPHATE MINING METHODS

Another important improvement has been in the construction of washers. With the most improved methods of hydraulic mining one washer can handle deposit from an area approximately one mile square in the pebble district. At the usual rate of mining this area is exhausted in from 7 to 10 years, after which time the washer must be either abandoned or moved. In the early days of the industry, washer framework was made of wood and at the end of the mining period it was so wracked and weakened that salvaging was out of the question. Since there was a tremendous quantity of heavy timber in each washer, all carefully fitted and framed, the abandoning of the structure, even though the machinery was salvaged, involved a substantial loss. Within the last 12 years, washers have been fabricated of steel, bolted together, so that one washer can now be used an indefinite number of times. It is estimated that the saving thus effected approximates 5 cents per ton of washed rock.

The means of segregating the wet rock into storage piles of different grades has been greatly improved to meet the market demands for more accurate grading. Sampling and analysis of rock before it leaves the washer bins determine the grade and consequent pile to which it will be assigned. From these wet storage piles the rock is reclaimed when needed, either by means of small draglines or cranes, or, as in one case, by a belt conveyor running through a tunnel under the storage piles.

The development and use of power in the industry has followed the spirit of the times. The old single-stage steam engine has given way to the electric motor. It is estimated that there is now over 91,000 horsepower of electric equipment in the pebble district, using about 150,000,000 kwhr annually. About 35 per cent of this is generated in the privately owned plants of the various companies and the remainder is purchased.

Indicative of the results of improvements in the past 50 years is the fact that the first rock was mined at a cost of about $12 per ton, and sold for about $20, whereas at present pebble rock must be mined to be sold at a profit at $2.25 to $3.50 per ton. As a further evidence of present-day efficiencies, it is estimated that the recovering of one ton of rock requires the handling of about 15 tons of solid, and an equal quantity of liquid material. When it is realized that this includes mining, washing, drying, analyzing, storing, overhead, and shipping, it can be seen that each ton must be handled at an average price of 12 cents per ton or less—truly an engineering feat in itself.

Background and Development of Detroit's Sewage Disposal Project

FROM AN ADDRESS PRESENTED BEFORE THE DETROIT SECTION

By CLARENCE W. HUBBELL

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AT long last the Detroit sewage collection, treatment, and disposal project is in the full swing of construction. In these pages Mr. Hubbell tells of the conditions which led to the inception of the project some three decades ago, and of the subsequent events that have influenced its development. A detailed description of the plant now on the way to completion is to appear in a forthcoming issue.

FOR more than a century the ever-increasing pollution of the Detroit River has been a matter of vital concern to the people living on its shores. They have seen the river front become a virtual cesspool into which the untreated sewage of two million people is daily dumped; they have seen their playgrounds and bathing beaches become a menace; and they have suffered epidemics from the use of polluted water supplies on which they have spent millions of dollars. Yet prior to 1923, not one gallon of sewage from the metropolitan area received any treatment.

Typical of the work that has been necessary to keep one jump ahead of this pollution are the progressive steps in the development of Detroit's water supply system. In 1873, the present Water Works Park site had been purchased (Fig. 1). It is located on the American shore opposite the upper end of Belle Isle about two miles below the foot of Lake St. Clair. From this site, steel intake pipes were extended to submerged cribs located in the center of the American channel. At the time of their construction, it was believed that no pollution would ever reach this source. However, in 1896–1897, the late Gardner S. Williams, M. Am. Soc. C.E., made an intensive study of the occurrence of typhoid and enteric fever in the Detroit area, which convinced him that certain epidemics had resulted from pollution originating at Port Huron on the St. Clair River, sixty miles above the Detroit intakes.

The survey indicated that a crib located on the far side of the American channel would be reasonably protected from pollution. Accordingly, in 1904, a 10-ft brick tunnel was extended 3,160 ft under the bed of the river to a surface crib located in deep water on the far side of the American channel, and the old intakes were abandoned except as emergency standbys. In 1912, the use of chlorine for the sterilization of raw water became necessary. In 1921, work was begun on the first filter plant located at Water Works Park. This plant, said to be one of the largest in the world, has a nominal capacity of 360 mgd, and the initial cost was well over $5,000,000. It was put in service in 1923.

In that same year, a commission of consulting engineers, of which the writer was a member, was appointed to "recommend a comprehensive plan for the construction of an additional water supply." The plan proposed involved a total estimated expenditure of $33,584,000, and included the new Springwells station with an ultimate capacity of 234 mgd; and 10½ miles of deep land tunnels to supply raw water for filtration at the site. The recommendations were adopted, and the new Springwells station was put in service in 1931.

The total cost of the water supply system to date, in round figures, is estimated at $117,000,000 of which, as has been indicated, an appreciable part has been spent for the extension of intakes to avoid pollution, and for the construction of filter plants to remove pollution from the raw water supply.

Were space available, equally cogent presentations of other problems might be made to show the effect of pollution on bathing beaches, on navigation interests, on property values, and on manufacturing.

The Waterways Treaty of January 11, 1909, recognized the pollution of boundary waters as an international problem, and provided that boundary waters between the United States and Canada, or waters crossing the boundary "shall not be polluted on either side to the injury of health or property on the other." The language is mandatory and clearly foreshadowed the necessity for remedial measures.

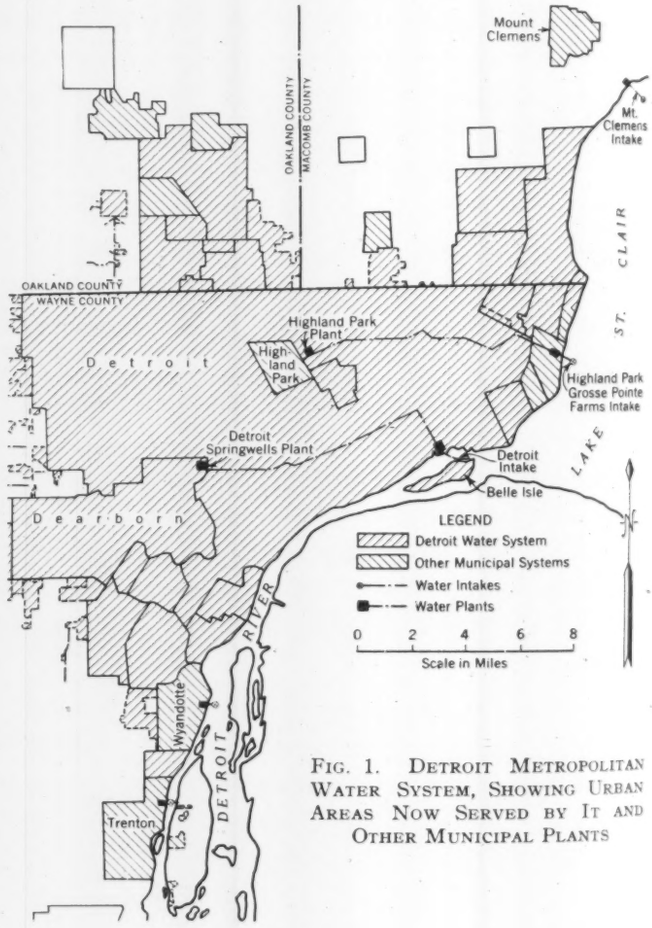


FIG. 1. DETROIT METROPOLITAN WATER SYSTEM, SHOWING URBAN AREAS NOW SERVED BY IT AND OTHER MUNICIPAL PLANTS

Following the signing of the treaty, the International Joint Commission proceeded to conduct a comprehensive survey of boundary waters to determine the source and extent of pollution existing in various locations in possible contravention of the treaty obligations. The survey of the Detroit River and the western end of Lake Erie was made in 1913. At that time the estimated population of Detroit and suburbs was 605,000 and the number of vessel passages through the river was 26,000 per season. The conditions found in the river were summarized as follows:

"Samples taken above the intake for the Detroit city water supply showed this to be an unsafe source of supply without careful treatment. . . . The water intakes of Walkerville and Windsor are both located in dangerous situations. . . . In spite of the efforts made by these towns to protect their supplies by means of chlorination, the typhoid rates remain too high. . . . From Fighting Island to the mouth of the river the water is grossly polluted and totally unfit as a source of water supply. . . . Unfortunately, Wyandotte, Trenton, and Amherstburg are taking their water supplies from this part of the river."

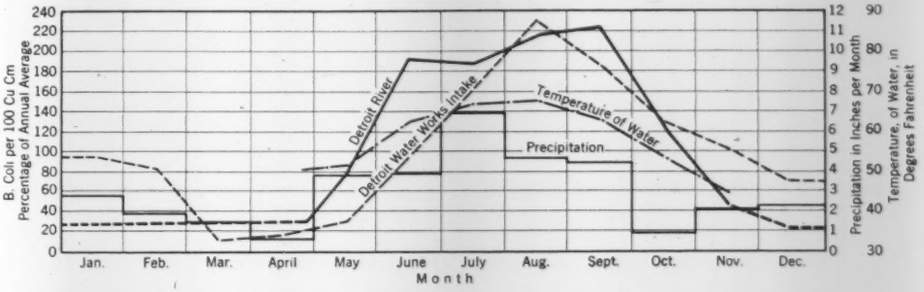

B. Coli per 100 Cu Cm
Percentage of Annual Average
Precipitation in Inches per Month
Temperature, of Water, in Degrees Fahrenheit
Detroit River
Detroit Water Works Intake
Temperature of Water
Precipitation
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.
Month

FIG. 2. SEASONAL VARIATION OF B.COLI IN THE DETROIT RIVER (SURVEY OF 1915)

Following this survey, the writer was retained to make a study of the sewage pollution and disposal problem for the city of Detroit. The specific problems submitted to him may be summarized as follows:

1. Review the work of the International Joint Commission.
2. Enlarge on any phase of the matter and make such further studies as may be necessary.
3. Report by what means, if any, the city of Detroit should undertake to purify its sewage, and what expense would be justifiable for that purpose.

A study of the work of the International Joint Commission brought out the need for additional data to coordinate the intermittent observations taken by them at 204 points in the river. Data were also needed to determine the seasonal variation in pollution. A second river survey was therefore undertaken. The more important findings of this survey may be stated as follows:

1. The number of B.coli varies with the seasons (Fig. 2). In general, samples taken in August show about $2\frac{1}{2}$ times the true annual average, while those taken in late fall show only one-quarter the average.
2. Pollution in the upper and middle reaches of the river hugs the shore line with remarkable persistence. For example, just below the mouth of the Rouge River, the average B.coli per 100 cc was 36,000 at the American shore, only 67 at the center of the river, and 1,550 at the Canadian shore.
3. In the lower reach of the river, the pollution is more widely spread because of the presence of islands and cross currents, and the influence of oscillations in the level of Lake Erie.

The first project for sewage treatment by Detroit was developed by the writer in 1915 and presented in his 1916 report. The design consisted essentially of high- and low-level interceptors, with Imhoff treatment and chlorination at two sites on the river front. Provision was also made for a future third unit. The plans were designed primarily to meet the needs of Detroit and serve a future population of 950,000; and they were approved by the district office of the International Joint Commission as adequate to meet the treaty obligations of the U. S. Government. The expenditure required for immediate construction was estimated at $6,091,000.

Then came what may be termed the period of Detroit's growing pains. The population doubled in less than ten years. During the time that the writer was city engineer, 1917–1922, some $40,000,000 was expended in public works, consisting largely of sewer construction to serve many square miles of newly annexed territory. By 1925, the population had reached about 1,500,000, and the 1915 project, which had not been built, was completely outmoded by this unpredictable expansion.

In 1925, the city appointed a special committee on sewage disposal, of which A. C. Marshall was chairman. This committee employed the late Harrison P. Eddy, Past-President Am. Soc. C.E., the late John H. Gregory, M. Am. Soc. C.E., and the writer as consulting engineers. A check survey of the river indicated an increase of 70 to 90 per cent in the pollution factor between 1915 and 1925, corresponding roughly to the increase in population during the same period. Old plans were reviewed and new studies made which resulted in the recommendation that a single plant to serve the metropolitan area be built on a 219-acre site on the river front below the mouth of the Rouge River. The cost of the project for immediate construction, including interceptors, was estimated at $39,600,000; and the design capacity was for a population of 2,400,000 as of 1940, with provisions for an ultimate population of 3,500,000.

The city proceeded with this project in good faith and about $6,000,000 was expended in the construction of intercepting sewers. However, proceedings instituted for the acquisition of the site, located in an adjacent municipality, met with adverse legislation which was insurmountable, and the plant was never built.

In 1929, legislation was secured under which sewage treatment could be accomplished as a county project. This appeared to be a happy solution of the legal, financial, and political difficulties. A committee was appointed, studies made, and additional reports secured. Later, this preliminary committee work resulted in the submission to PWA officials of a $23,000,000 county project which, however, died in Washington.

Meantime, local conditions became acute, particularly in the Rouge River valley. Detroit was jointly interested with Dearborn in this problem, and for its solution proposed an activated sludge plant, located in the upper valley, while the city of Dearborn proposed a chemical precipitation-magnetite filter plant. Early in 1931, the consulting firm of Hubbell, Hartgering and Roth, Inc., was retained by Dearborn, and in the same year proposed a third plan, which was adopted and carried out. This plan included the construction of the now well-known Dearborn West Side sewage treatment and sludge disposal plant, and the remodeling of the old East Side Imhoff tanks built in 1923. The designed capacity of these four 33 by 100-ft tanks was originally 5 mgd. The

installation of specially designed inlets, together with suitable equipment for the daily withdrawal of raw sludge, increased their capacity to 15 mgd with no loss in efficiency. This local project was completed in 1932 at a total cost of approximately $600,000, and at the present writing handles the sewage from a population of about 235,000, including some 160,000 who live in Detroit and are served on the basis of a contract which has four years yet to run.

In 1933, an effort was made by Governor William A. Comstock to secure sewage disposal for municipalities in St. Clair, Macomb, Oakland, and Wayne counties on the basis of a 100 per cent federal grant. This project included 58 municipalities and institutions contributing sewage, directly or indirectly, to boundary waters between Lakes Huron and Erie (Fig. 3). An application for $25,000,000 filed late in 1933 was formally rejected by Administrator Harold L. Ickes early in 1934. Following this, a Metropolitan Sewage and Water Commission appointed by the governor of the state continued to work for an intercounty metropolitan project to include parts of Oakland and Macomb counties for the protection of beaches along the westerly shore of Lake St. Clair, above Detroit, at least as far as the Clinton River. This feature is not included in the city project now under construction but remains an essential part of the problem for which a solution must be found in the near future.

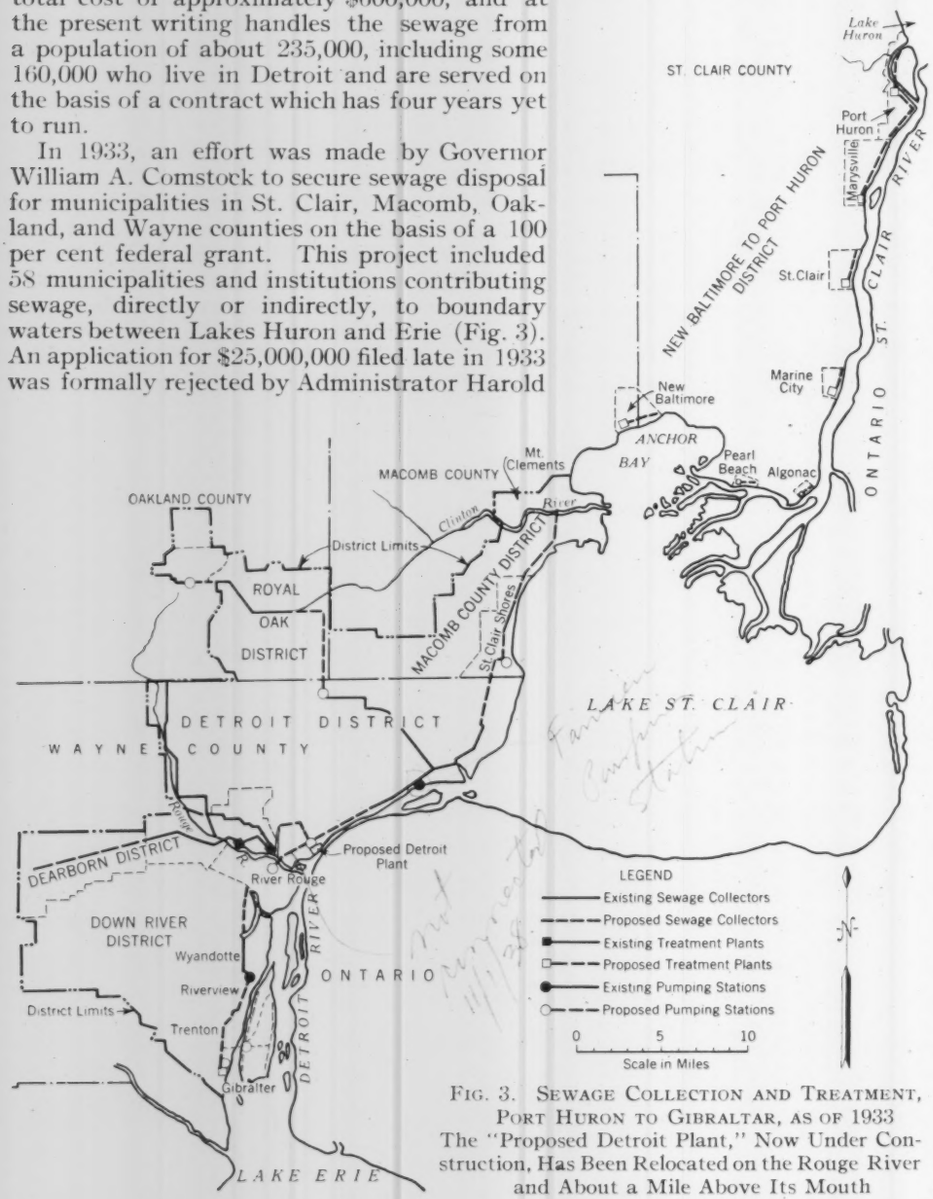


FIG. 3. SEWAGE COLLECTION AND TREATMENT, PORT HURON TO GIBRALTAR, AS OF 1933
The "Proposed Detroit Plant," Now Under Construction, Has Been Relocated on the Rouge River and About a Mile Above Its Mouth

Finally, in the fall of 1933, the city of Detroit succeeded in securing the approval of a modified PWA project on the basis of a $9,000,000 grant and an $11,000,000 federal loan. The project comprised collecting sewers and a treatment plant to serve the city of Detroit and eight contiguous municipalities located in the northeasterly third of Wayne County, having a combined population of 1,720,791 as of 1930.

On January 3, 1936, the board of three consulting engineers who reported on the 1925 project was reconvened in Detroit. At that time portions of the collecting sewer system, essentially as outlined in the 1925 project, had been built or were under construction, and a new 96-acre plant site had been selected on the northerly bank of the Rouge River, one mile above its confluence with the Detroit River.

The services of the consulting board on this project have included research and preliminary design studies; conferences with federal, state, and city officials; determination of the methods of treatment to be adopted and the type of equipment required; the preparation of basic design data; and upon request of the city, reports on various special features and technical problems affecting the design, operation, and efficiency of the plant.

In general, all designs are based on an estimated population of 2,400,000 as of 1950, and an ultimate population of 4,000,000. The volume of sewage to be treated is estimated at 175 gal per capita per day for average conditions. The interceptors that will collect and deliver sewage to the main pumping station comprise the Detroit River interceptor, which will protect some twenty miles of river and lake front; the Lonyo interceptor, which will collect sewage from the Rouge River valley; and the Oakwood interceptor, a branch of Lonyo, which will extend across the Rouge to reach Detroit areas located on the opposite side of the river. This branch is also designed for future extension to the upper Rouge Valley.

The pumping station is essentially a circular caisson having an outside diameter of 113 ft, and sunk to rock through about 85 ft of soft clay. The average lift will be about 30 ft, and the ultimate capacity with eight pumps installed will be 2,000 cu ft per sec.

After pumping, the sewage passes through rack screens, grit chambers, and sedimentation tanks. Raw sludge drawn from the tanks will be conditioned with lime and ferric chloride, dewatered by vacuum filters, and then incinerated; while the effluent from the tanks will be treated with chlorine and discharged through a masonry-lined tunnel over a mile long, terminating in a submerged crib located in swift-flowing water in the Detroit River some 400 ft from the harbor line.

Thus is presented, as briefly as possible, the origin and present status of the Detroit sewage treatment and disposal project. I cannot close this review without expressing my appreciation of the privilege which has been mine of working with two able engineers and personal friends, Harrison P. Eddy and John H. Gregory, on this their last work, which neither lived to complete.

Large Delivery Lines for the Colorado River Aqueduct System

From an Address Presented Before the Los Angeles Section

By JULIAN HINDS

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

ASSISTANT CHIEF ENGINEER, THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF.

IN the June 1938 issue of "Civil Engineering" the construction of Cajalco Reservoir, the main storage unit of the Colorado River Aqueduct system, was described. This month the story of that gigantic water supply system is carried further, with Mr. Hinds telling of the manufacture and installation of the 46 miles of steel and precast concrete pipe which form a part of the system leading from Cajalco to the various towns in the Metropolitan Water District of Southern California. New welding methods and special pipe-handling equipment are among the interesting features.

THE main Colorado River Aqueduct terminates in the Cajalco Reservoir, ten miles southwest of Riverside and about sixty miles southeast of Los Angeles. From that storage unit, water will be conveyed to various points of use by a network of "feeder lines." This network does not constitute a distributing system in the usual sense—as the Metropolitan Water District attempts no retail deliveries—but is designed to "feed" in a wholesale manner the distributing systems of the cities composing the District.

The designed average flow of the main aqueduct is 1,500 cu ft per sec. The feeder system must eventually have an equivalent capacity, less transmission losses and plus any provision for meeting peak demands. Only a part of the ultimate feeder capacity will be required at first. Convenience in serving a widespread area, the economy of progressive development, and flexibility for adjustment to unknown ultimate population distribution, favor the gradual development of the system in units of convenient size.

The area in which the aqueduct flow will be consumed is shown on the map, Fig. 1. The ultimate system will consist of two or more main lines leading out of Cajalco and branching toward the western ends to cover the area. The first development might have consisted of a part-capacity line in each of the ultimate locations, but it was found more economical to build first one complete full-size unit, adjacent areas being supplied by cross branches. A high line, skirting the upper rim of the coastal basin, was selected as the most convenient first development. Cross-feeders from this line to the lower areas operate under ample hydraulic gradients.

This upper feeder from Cajalco to Eagle Rock has a total length of 62.5 miles—made up of 10.3 miles of steel pipe, 36.0 miles of concrete pipe, and 16.2 miles of tunnel. The designed capacity is 750 cu ft per sec from Cajalco to San Dimas, and 510 cu ft per sec from San Dimas to Eagle Rock, based on values of 0.014 and 0.012 for Manning's n, in enameled steel and precast concrete pipes, respectively. Construction of the line is practically completed. The present discussion will relate to only a few special details of the steel and concrete pipe lines.

WELDED STEEL PIPE

Steel line is used only for the high-head siphon across the Santa Ana River, which has an over-all length of 10.3 miles. The head on this siphon varies from 20 to 485 ft, the pipe diameter from 9 ft 8 in. to 11 ft 6 in., and the shell thickness from $^{17}/_{32}$ to $^{31}/_{32}$ in. The line crosses the

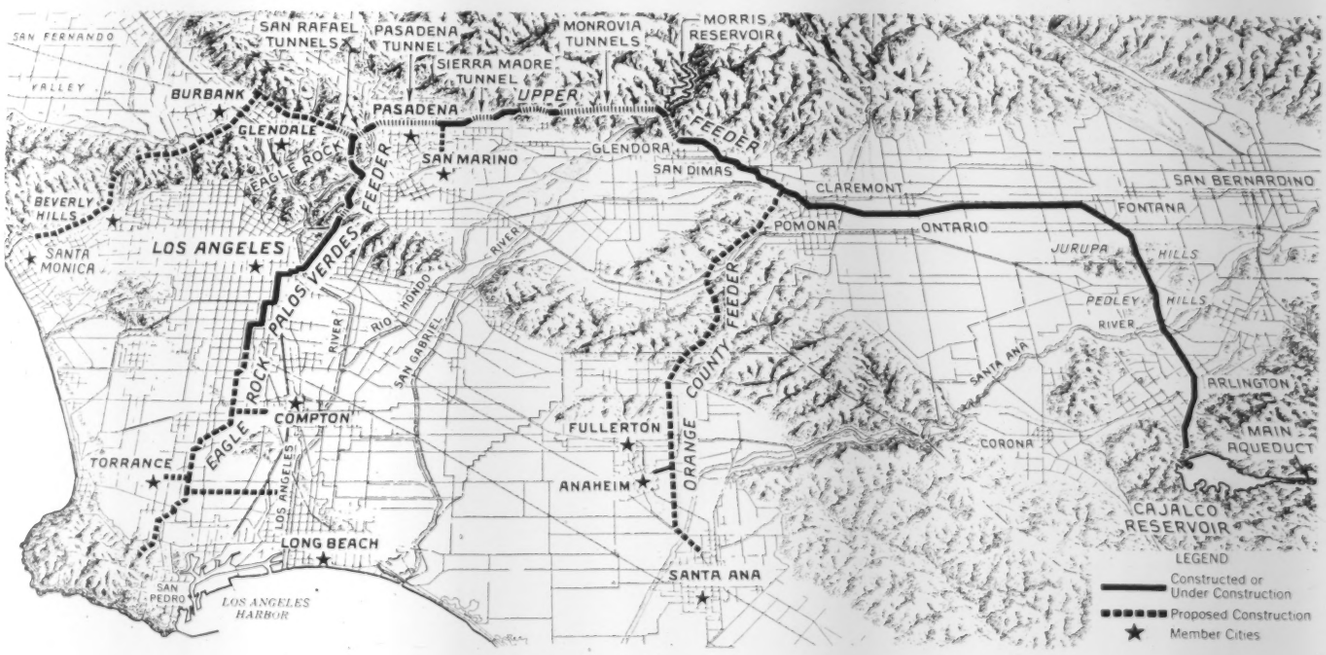
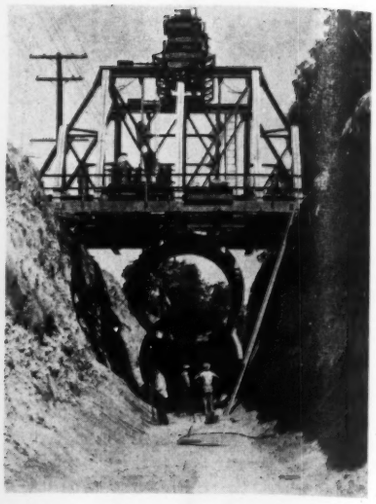


FIG. 1. FROM CAJALCO RESERVOIR, COLORADO RIVER WATER WILL BE CONVEYED TO THE CITIES OF THE METROPOLITAN WATER DISTRICT BY A SYSTEM OF FEEDER LINES

EACH OF THE THREE COMPANIES THAT SHARED THE CONCRETE PIPE CONTRACTS EVOLVED A DIFFERENT METHOD OF INSTALLATION

The Largest Pipe Sections Weighed 42 Tons Each



river on a bridge; otherwise it is buried in trench. The diameters were determined by the "economic slope theory," and plate thicknesses were computed for a shell stress of 13,500 lb per sq in. The minimum plate thickness of $^{17}/_{32}$ in., for sections under low heads, was based on considerations of external loads and buckling strength.

The pipe was furnished and installed under contract with the Western Pipe and Steel Company of Los Angeles. Excavation and backfill were sublet to the Morrison-Knudsen Company, and a part of the pipe fabrication to the Consolidated Steel Corporation, Ltd., of Los Angeles. The pipe was fabricated in 33-ft lengths in Los Angeles. All shop welds were made by automatic machines. An interesting feature was the development by the Western Pipe and Steel Company of one-pass welding for plates up to $^{31}/_{32}$ in. in thickness, the maximum used in the line. The essential features of the a-c welding process used for this purpose are shown in Fig. 2 (left). The plate edges *A* and *B* were first tacked and then closed by a light hand-applied seal weld, as shown. In the machine, the pipe was supported by the copper welding strips *C*, *D*, and *E*, the latter of which was water-cooled. The trough, *F*, was filled with a blanketing flux through which the welding rod, *G*, ploughed at about 10 in. per min. Under proper control of the amperage and voltage, the tack welds and the seal weld were completely melted out and a full penetration of the plate was secured. The flux melted, excluding the air, holding the heat of the weld long enough to effect some annealing and producing other beneficial effects. The portion of the weld filling the groove in the plate, *E*, was chipped away in order to give a smooth interior finish.

For longitudinal joints, the trough, pipe, and backing-up strip were stationary, and the welding head movable. For transverse joints, the head and water-cooled backing-up strip were stationary and the pipe revolved.

The welding head used by the Consolidated Steel Corporation, Ltd., is shown in Fig. 2 (right). This head and the backing-up strip were stationary, the pipe traveling by them. The flux was fed onto the weld area from a hopper. This company made no attempt to get complete penetration at one pass, but chipped out the back side of the first weld and completed with a machine-placed d-c weld as indicated.

Where the plate thickness exceeded $^{5}/_{8}$ in., the welded pipe was moved into a closed furnace and annealed for one hour per inch of thickness, at a peak annealing temperature of not less than 1,100 F. Each pipe section, after completion, was tested hydraulically to a stress in the steel of 22,000 lb per sq in.

The pipe was protected against corrosion by coal-tar enamel on the inside and by an outside gunite coating $^{3}/_{4}$ in. thick. For bad soil conditions, a coating of coal-tar enamel was also used on the outside, beneath the gunite. The inside enamel was applied centrifugally in the shop over a sprayed-on priming coat. The enamel was selected by careful testing to insure stability and adherence under all likely temperature conditions. It was applied at a temperature of approximately 475 F, and at a peripheral spinning speed of about 1,100 ft per min. For best results, it was found necessary to preheat the steel pipe to a temperature of about 190 F. The enamel was heated in an electrically controlled gas-fired furnace, mounted on a car, traveling along the projected center line of the spinning pipe, and was delivered through a cantilever spout having a 12-in. side weir at its outer end. The travel of the car and the spinning speed were adjusted for a 6-in. pitch, thus laying the enamel in a continuous double-spiraled ribbon. With careful application, the spirals were not apparent in the finished work.

Outside enamel was poured and spread by hand as the pipe was slowly revolved. Strips about 12 in. wide at

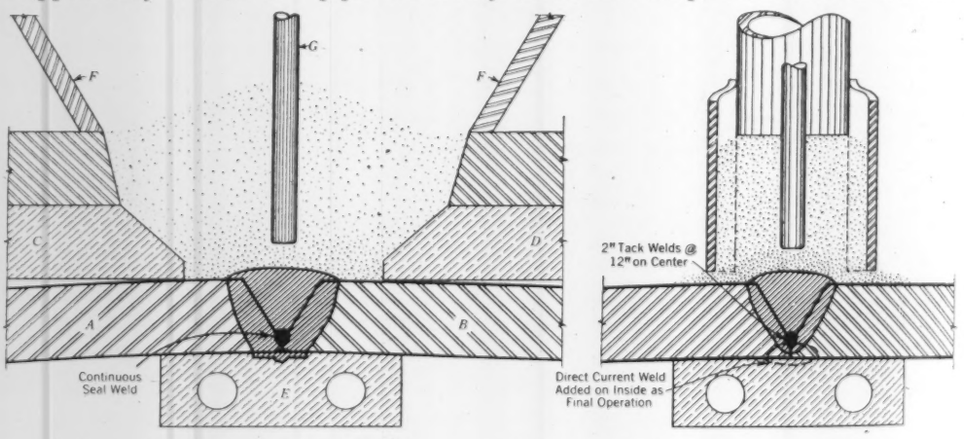


FIG. 2. TWO METHODS OF MAKING THE LONGITUDINAL WELDS IN THE STEEL PIPE

each end of each section, both inside and outside, were left for hand-daubing after the completion of the field welding. The enamel as applied was $^3/_{32}$ in. thick, plus or minus $^1/_{32}$ in., and on the inside presented an extremely smooth, mirror-like surface. The initial resistance to flow will be low. The value of 0.014 for n, used in design, allows for considerable deterioration with age.

The entire surface of the enamel, both inside and outside, was inspected by an electrical detector. The detector consisted of a broad wire brush, energized by a 5,000-v, 0.012-amp, electric current, supplied by a transformer attached to a 110-v, a-c outlet. When this brush is passed over the enamel surface, imperfections are revealed by sparking. These imperfections are cut out and repaired by hand.

The enameled pipe sections were shipped to the field in freight cars, unloaded by a gasoline-propelled caterpillar gantry, and placed on rolling supports preparatory to receiving the coating of gunite. Self-furring welded wire mesh fabric, 2 in. by 4 in. by 12-gage, was stretched around the pipe, after which the gunite was applied in two coats. The gunite was water-cured until the evening of the day placed and then, while still wet, was protected by two coats of sprayed-on coal-tar cut-back. This cut-back was coated with whitewash for temperature control.

After the gunite had been cured for a minimum of seven days, the pipe was loaded by the gantry onto trucks, transported to the trench, laid by an electric crane, and welded. All inside and outside field welds of the bell and spigot joints were executed by hand, using portable d-c welding machines. The number of passes varied from four to seven, depending on the plate thickness. Each joint was provided with four taps and was tested by forcing a soap solution under 100-lb pressure into the space between the two welds. After testing, the enamel and gunite coatings were completed over the joint areas and the pipe was backfilled by puddling.

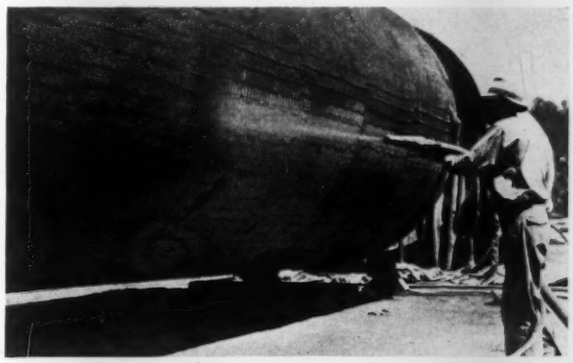
In order to prevent distortion, the pipe was supported by steel frames across the ends. After laying, wooden stulls were kept in place until after the pipe was backfilled.

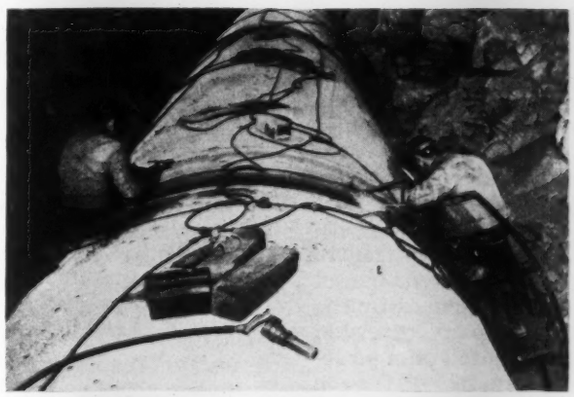
PRECAST CONCRETE PIPE

Except for a few short monolithic canyon crossings, and necessary tunnels, all parts of the upper feeder other than the Santa Ana River siphon were of precast concrete pipe. Diameters ranged from 9 ft 8 in. to 12 ft 8 in., the largest precast pressure pipe so far attempted. Heads ranged from nominal up to 292 ft. Shell thickness varied from 10 to 13 in. Backfill depths were from 4 to 20 ft over the top of the pipe. Reinforcing was computed for a combination of external and internal loading.

For heads less than 80 ft, a combination of circular and elliptical cages was used. For greater heads, a thin steel cylinder was added to the assembly for water-tightness. The cylinder steel was considered as available for resisting internal pressures, but was ignored in computing bending stresses because of doubtful bond strength. The bar reinforcement was of modified intermediate grade, delivered to the job in continuous coils. The pipes were cast vertically in 12-ft lengths. The mortar joint was used on $9^1/_2$ miles of low-head pipe. Elsewhere, steel and lead joints were used, attached to bar cages or bar-and-steel cylinder cages, as required.

The pipe was installed under three separate contracts. Complete manufacturing and curing plants were established adjacent to the line. Procedures of the various contractors differed in detail but were similar in all essential respects.





THREE STEPS IN THE MANUFACTURE AND INSTALLATION OF THE STEEL PIPE

Top: Applying the Gunite Coating. Center: Welding a Field Joint. Bottom: Testing the Field Enamel

Bar reinforcing was wound into cages on an electrically driven drum and welded to the longitudinal steel to form a unit capable of being handled, which included the joints rings and the steel cylinder where used. A traveling crane transferred the completed units to storage and to the forms.

Cement and aggregates were brought to the job in cars or trucks, handled and stored by standard methods, and automatically weighed out into 4-cu yd batches. The mixed concrete was discharged into 2-cu yd buckets resting on cars operating on a railway track paralleling the casting yard. These buckets were lifted by a traveling crane and dumped into a hopper on a movable placing gantry, straddling the pipe form to be filled. The concrete was withdrawn from this hopper through a swivel chute of 12-in. diameter, revolved in such manner as to assure uniform filling of the form.

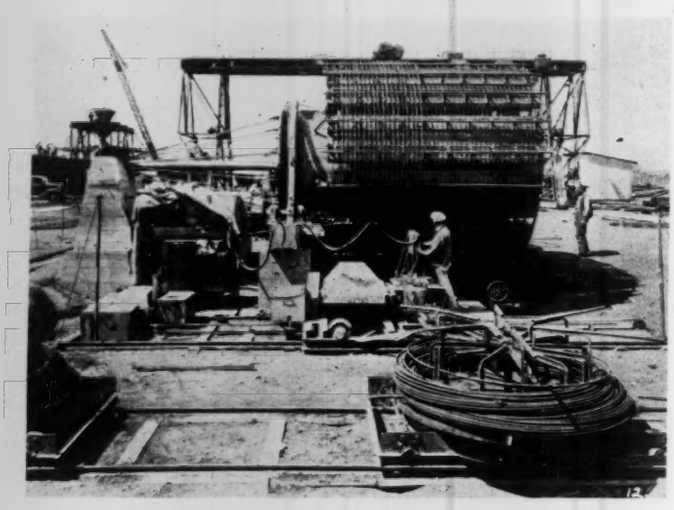
The concrete was moderately vibrated by stationary electric vibrators clamped to the outside forms, but working was principally accomplished by a new and ingenious device. This device consists of a spring-steel rod $^1/_2$-in. square, about 3 ft longer than the depth of the form, and rotated at about 500 rpm by a small air motor.

The rotating rod is pushed down into the concrete along the face of the form. A slight kink near the lower

end and a little manipulation by the operator cause it to creep along the face of the form. The entire inner and outer surfaces are treated in this manner, and the resulting surfaces are very smooth and free from the air and water "pock-marks" common where vibrated concrete is placed against high vertical forms. This treatment is reported to have cost a little less than 1 cent per sq ft of surface treated. (This device is protected by patents.)

Forms were stripped after about 12 hours and the pipe was tipped off the base ring during the third day. The forms were handled by the same crane that handled the reinforcement and the concrete. The pipes were tipped by a hoist attached to the same gantry which carried the placing hopper.

The outer surfaces of the pipe were kept drenched



WINDING A BAR CAGE FOR THE CONCRETE PIPE

after stripping until late afternoon or evening, and then sprayed while wet with two coats of coal-tar cut-back. The top of the pipe was closed by a portable cover and the inner surface was kept wet until tipping. After tipping, both ends were closed and the water curing continued for a period of 12 days, after which the pipe was ready for placing.

The cured pipe sections were rolled onto heavy trailers and transported to the trench, where they were placed by special traveling equipment. The placer used by the American Concrete and Steel Pipe Company consisted of a steam-operated stiff-leg derrick mounted on a structural-steel frame, which traveled on a track of 48-ft gage spanning the trench. This placer was capable of handling 45 tons on a 36-ft radius. The heaviest pipe section weighed over 42 tons.

The placer used by the J. F. Shea Company consisted essentially of two bridge-type trusses spanning the trench and traveling on rails laid to a 38-ft gage. The pipe was rolled between these trusses and lowered by slings from an electric hoist, movable in all directions. The lesser track width of this placer gave a little trouble in caving ground but was necessary because much of this company's operations were in city streets where working space was restricted.

The pipe furnished by the United Concrete Pipe Company was handled with a heavy crawler-type crane.

Although soil conditions were usually favorable, all of these large-diameter precast pipes were bedded in a concrete cradle. The outside of the mortar-type joints above the cradle were pointed with a stiff mortar. Strips of building paper were used on the lower section of the pipe to prevent cradle concrete from entering the joint. The inside joint was pointed to within one inch of the surface of the pipe. The inner space was then filled with a thin 1:3 cement and sand grout, poured in through a port-hole in the outside top of the joint. After completion of backfill the inside joint was completely filled with mortar, and trowel-finished.

A SECTION OF STEEL PIPE IN THE TRAVELING GANTRY

The lead and steel joints were lightly calked when placed, then backfilled and allowed to settle before final calking. As a final operation, the calking space was filled with gunite.

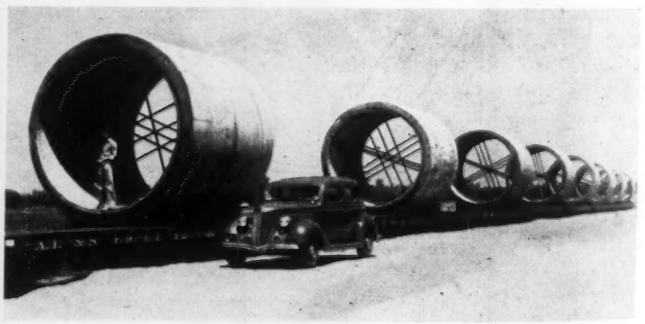
After completion, all pipes were tested for leakage under full operating heads. The results are shown in Table I.

TABLE I. LEAKAGE TESTS ON COMPLETED PIPE LINES
(In gallons per inch of diameter, per mile per day)

SCHEDULE*	DIAMETER IN INCHES	LENGTH IN MILES	ACTUAL LEAKAGE LOSS		
			Welded Steel Pipe	Precast Concrete Pipe Mortar Joints	Precast Concrete Pipe, Lead and Steel Joints
1P	140	2.33	..	...	17
2S	116 to 138	10.33	7	...	...
3P	140	3.81	..	...	12
4P	152	4.90	..	33	...
5P	152	4.71	..	21	...
6P	140	5.17	..	...	20
7P	140	5.64	..	...	31
8P	123	4.64	..	...	57
10P	116	1.99	..	...	27
11P	116	0.78	..	...	67
Leakage loss allowed by the specifications			15	100	100

* Successive lengths of the pipe line, running from Cajalco toward Eagle Rock.

All the work described was done by contract, by the contractors named, under the general supervision of R. B. Diemer, M. Am. Soc. C.E., engineer in charge of distribution. F. E. Weymouth, M. Am. Soc. C.E., is general manager and chief engineer of the District, and the writer is assistant chief engineer.



TRANSPORTING PRECAST CONCRETE PIPE SECTIONS BY RAIL—ONE SECTION TO A CAR

The Role of the Library in Engineering Education and Research

By HARRISON W. CRAVER

DIRECTOR, ENGINEERING SOCIETIES LIBRARY, ENGINEERING SOCIETIES BUILDING, NEW YORK, N.Y.

EVERY so often, somebody compiles figures on the money saved by experimental research. It might be informative to have some data on money wasted in the same way. The debit entries, of course, would comprise the cost of every research project that simply duplicates an equally reliable study by an earlier investigator. All too frequently problems are sent to the laboratory when the answers might be obtained, almost for the asking, in a technical library.

Mr. Craver tells here something of the resources of the modern engineering library, and makes valuable suggestions on how to use them effectively. Bibliographic aids and modern copying methods, he points out, are rapidly making the entire book resources of the world available to every worker, regardless of location. His article is an abstract of an address delivered at Vanderbilt University, Nashville, Tenn., on February 4, 1938.

UNTIL recent times, the library needs of engineers have received rather scant attention. The physical sciences and engineering have not been adequately represented in any but the largest of our general libraries. In most universities, even those with substantial libraries, the provision for engineering has been below the level of that provided for other departments. Often it has been inadequate for any but the simplest needs.

Various reasons (or excuses) for this condition are given. One is that engineers in the past have not been bookish people. Another is that until recent years the published works on engineering were written chiefly for use as college texts. And a third has been the lack of librarians with experience in engineering.

Past conditions, therefore, have been far from ideal. A literature that was limited in scope and largely elementary, and with custodians lacking the proper qualifications, did not conduce to the growth of strong libraries. As a consequence, the development of engineering libraries has been almost entirely a twentieth-century phenomenon. Today there are a number of libraries devoted to applied science, as well as numerous departments in colleges, universities, and large public libraries that offer a wealth of such material, adequately catalogued and administered by competent librarians.

Their growth has paralleled that of our research institutions and has greatly facilitated research work. Thanks to them, it has become possible for the research worker to obtain access, in one way or another, to any published material on any subject, usually with little delay and at moderate expense. Bibliographic paraphernalia has been developed which is constantly making the literature more accessible, and new methods are being devised for copying and distributing what is needed. The change in conditions during the past twenty years can scarcely be described.

PERIODICALS ARE OF PRIMARY IMPORTANCE

The material of an engineering library falls roughly into three categories—periodicals, books, and bibliographic equipment. Of these, the first is the most essential.

If the eighteenth century was the age of the pamphlet, and the nineteenth that of the book, the twentieth is the age of the periodical. Never before has there been such a quantity and variety of magazines and journals.

In such fields of active development as science and technology they have pushed the book into the background. The strength of a research library can be measured today by the size of its periodical department. It is in the periodical that one looks to find the details of new discoveries and inventions, fresh from the discoverer's mind and in his own words. Here, too, are found those hints of new fields, suggestions of unexplored paths, that are the inspiration for further investigations.

The number of periodicals is amazing and far beyond the purchasing power of any libraries but the largest. Fortunately, however, the usual requirements can be met by a relatively small number. Fifty periodicals probably will cover all general needs. Another fifty will be adequate for ordinary research work. Beyond this, material can be obtained as needed from other centers.

In spite of common opinion, books, as distinguished from periodicals, are of secondary importance in the engineering library. One reason for this is the fact that our books are so largely written for use as undergraduate textbooks. Another reason that lessens their importance is that they always lag behind current knowledge and hence rapidly become too out of date to be very useful. Obsolescence occurs at a high rate, five years of useful life being perhaps a fair estimate. After that, most current books are either revised or supplanted by better ones. The book collection in use at any time is therefore relatively small. Most needs can be met with remarkably few titles, say 4,000 or 5,000.

It should be pointed out, however, that the engineer of today, to an extent never realized in the past, is coming to perceive that scientific principles form the basis of all his methods. Out of this development are coming books of a new type. Not intended for classroom use, they can deal with more limited fields and do so more comprehensively. Basing their treatment upon exact science, they insure longer useful life for themselves. The quality and durability of our engineering libraries is therefore improving rapidly.

BIBLIOGRAPHIC AIDS TO RESEARCH

Supplementing the books and periodicals, every library should have adequate bibliographic equipment. This consists of indexes, abstract journals, and bibliographies. No library can have too many of those aids to research. The smaller the library is, the more important they are, for they provide guides to what has been published, and what is not available locally can usually be obtained, if its existence is known. The number of abstracting services is large, and is increasing. Considerable overlapping exists, but is not a cause for worry, as the abstracting and indexing vary with the different viewpoints of those for whom the services are intended.

Such publications as *Engineering Abstracts*, *Science*

Abstracts, *Chemical Abstracts*, and *Metallurgical Abstracts* are fundamental necessities to every research library. These journals, together with such indexes as the *Engineering Index* and the *Industrial Arts Index*, and the national bibliographies of the leading countries, are the means through which any research problem is most easily approached.

READING ROOM, ENGINEERING SOCIETIES LIBRARY, NEW YORK
The Library, Maintained Jointly by the Founder Societies, Is Well Equipped to Serve Engineers Who Cannot Visit It in Person. It Offers Special Services in Searching and Translating, Maintains a Rental Collection of Books for the Use of Members Residing Anywhere in North America, Has a Fine Photostatic Department, and Receives Nearly All the Important Engineering Periodicals

HOW IS THE LIBRARY USED EFFECTIVELY?

Tedious as library research is, it indubitably is the proper first step in any investigation. No better means exists for ascertaining the extent to which any field has already been covered, the results obtained, and the points where further study is needed. Much time-consuming, expensive experimental work can be avoided through the library. Every experienced librarian can cite specific instances of work that was done twice, often at large expense, because through insufficient reading the first investigation was unknown to the later student. Large sums have been invested in patents that were overthrown by searching the literature at relatively small cost.

There is no universally applicable technique for using the library effectively; it is an art that each must learn for himself. However, a good method is first to ascertain whether any comprehensive treatises exist, by examining the most comprehensive bibliographies available. As a preliminary, this treatise will serve as a summary of work prior to the date of publication, or approximately so. Subsequent to the date thus established, the first search is for bibliographies that will be helpful. Usually none can be found, or those found are suspiciously brief and incomplete. Except for those lucky occasions when a satisfactory bibliography is to be had, one may as well turn at once to the abstract journals and indexes, compile his own list of references that offer promise, and obtain these by consulting the originals.

Proceeding in this way, one is enabled to cover the subject as thoroughly as the occasion requires or as time permits. Eventually, it is possible, or should be, to disinter everything that has been published. This, however, is seldom done and the "complete" bibliography is exceedingly rare.

As thus outlined, the searcher's method seems very simple. Actually, of course, complications arise that call for all his skill and knowledge. Indexing and classifying are arts that are far from perfect, and it often is difficult to trace the desired subject through all the vagaries of various workers.

In different indexes various names are used for the same things. Terminology changes from time to time. Articles that fall into one group when classified by a physicist sometimes are classified quite differently by an electrical engineer. Practically never does one index or abstract journal cover its field completely. In addition, indexes seldom go beyond the main subject of an article, and nothing but direct examination will discover the hidden information within it. All these difficulties arise to hamper the searcher, but if he is sufficiently persevering and industrious, he eventually will find what exists on his subject.

A search of any magnitude is almost sure to bring to light material not in the local library, which must be consulted elsewhere. In the past, this often has been difficult, if not impossible, as many libraries are unable to lend their possessions. Fortunately, modern methods of copying have developed to a stage where material can be copied cheaply and accurately. The use of the photostat has spread rapidly in recent years, until most libraries can supply photographic copies. Very recently attention has been directed towards microcopying upon film, a method of great promise for the research worker. The "microfilm" method is especially valuable for reproducing long documents, such as complete books, more cheaply than was possible in the past. Some form of projector is necessary to produce a readable image, and a variety of apparatus is already available.

Through the development of bibliographic equipment which enables librarians to ascertain where given documents exist, and of good methods for reproducing them, the entire book resources of the world are rapidly becoming accessible to every worker, regardless of his location. Current tendencies undoubtedly will affect the management of the college library. No longer will it need to be considered as an isolated institution that must rely wholly on itself; instead, it may be considered as one of a system of cooperating organizations, with resources pooled to a certain degree. Intelligent use of the facilities available for obtaining seldom-wanted material through means other than direct purchase should release additional funds for ordinary needs.

THE LIBRARY AS A LABORATORY

An engineering library may be regarded as a laboratory. Like other laboratories, it is a place for study and research. Like them, its assets are personnel, equipment, and housing. Also like them, these assets are important in the above order. A good librarian will get better results with meager equipment than a poor one can get with all the books in print. The best collection of books possible is desirable, but best and largest are not synonymous terms. Good housing is always an advantage, but to sacrifice books and personnel for a handsome building is a frequent mistake. After all, the Curies did their brilliant work in a shed, and many libraries are giving excellent service in poor quarters.

Because the library is an essential tool in research work today, and promises to become even more important hereafter, college students would profit immensely from more instruction in its use. Too many leave college with no idea of the technique of searching, and hence find themselves helpless when cut off from professional advice. If, from time to time, problems were assigned for solution in the library, instead of the laboratory, this might be corrected to a degree.

ENGINEERS' NOTEBOOK

This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems. Reprints of the complete department, 8½ by 11 in., suitable for binding in loose-leaf style, are available each month at 15 cents a copy.

Accurate Computations by Approximate Integration

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THE application of approximate integration to many engineering problems is usually a more or less informal, unconscious process. Thus the moments in a beam supporting a load of varying intensity are found by replacing the continuous load with a series of concentrated loads. Even in such a simple problem, however, the

FIG. 1

FIG. 2

chances of achieving accurate results with a minimum of effort are greatly enhanced by the understanding of a few principles.

If a function is plotted as a curve, then its integral is the area under the curve—this principle is very useful because, among other things, it makes the subject easy to illustrate and to visualize. One criterion for any accurate method of determining the area of a curve is that it should become an exact method when applied to a straight-sided figure. Two very simple methods of division apply exactly to a triangle. In Fig. 1,

$$A = \left(\frac{1}{2}y_0 + y_2 + y_4 + y_6 + \frac{1}{2}y_8\right) dx \ldots\ldots [1]$$

In Fig. 2,

$$A = (y_1 + y_3 + y_5 + y_7)\, dx \ldots\ldots [2]$$

In both of these cases it will be observed that the number of small triangles outside the figure is equal to the number of small triangles inside it. Note also that very troublesome complications would be introduced if unequal divisions were used.

If the moment at a point in a uniformly loaded beam

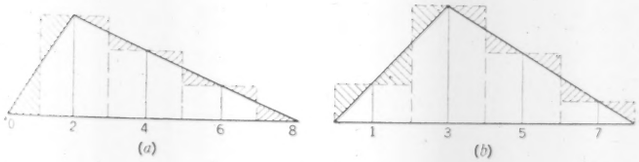

FIG. 3

is regarded as the area under the influence line, the solution will disclose one important difference between the two methods just shown. For a moment at an even-numbered point (Fig. 3*a*) the positive and negative triangles balance; for a moment at an odd-numbered point (Fig. 3*b*) they do not. Hence moment calculations should be confined to even-numbered points. Either Eq. 1 or Eq. 2 can be used, but in the latter case the moments must be found at one set of points and the loads at another. In a more complicated problem this may mean a considerable hardship; in an arch, for example, it would necessitate two complete sets of coordinates and cross-sections, one for elastic properties and the other for stress investigation. Balanced against this disadvantage is the fact, which will be proved a little farther on, that for the areas of curves Eq. 2 is twice as accurate as Eq. 1.

For a short length of curve (Fig. 4), which will usually not depart very far from a parabola, the shaded area under the curve is equal to $^2/_3\ bh$, and the shaded area outside is equal to $^1/_3\ bh$. These shaded areas represent, respectively, the errors of Eqs. 1 and 2 applied to other than straight lines. Evidently a very high degree of accuracy could be attained by adding together one-third of the area obtained by Eq. 1 and two-thirds of the area obtained by Eq. 2. This is, in fact, the procedure known as Simpson's rule, which gives the exact value of the integral of the function $a + bx + cx^2 + dx^3$. Applied to Fig. 1, it would give

$$A = \left(\frac{1}{2}y_0 + \frac{4}{3}y_2 + \frac{2}{3}y_4 + \frac{4}{3}y_6 + \frac{1}{3}y_8\right) dx \ldots\ldots [3]$$

In any case, if the function to be integrated is plotted, or even roughly sketched, it will usually be evident whether the errors to be expected will be positive or negative, large or small. As an example, consider the moment of inertia of certain areas (Fig. 5). The function to be integrated is yx^2. For a rectangle (Fig. 5*a*), this is a concave curve, indicating that the result will be large if Eq. 1 is used, small if Eq. 2 is used. For a triangle(Fig. 5*b*), the situation is just the reverse. The curve $\frac{dI}{dx} = yx^2$ is predominantly convex; Eq. 1 will give too small results, Eq. 2 too large.

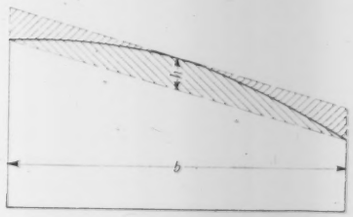

FIG. 4

The foregoing examples can be made to illustrate how easy it is to get into trouble using special refinements indiscriminately. One interesting way to correct Eq. 2 for the moment of inertia of the rectangle is to add to the results obtained by that formula the moments of inertia of the individual divisions of the rectangle about their own axes, since yx^2dx evidently corresponds to Ax^2 in the formula for moment of inertia, $I_x = Ax^2 + I_o$. This same correction added for the triangle, however, would only make the error greater than before. The difference, of course, lies in the fact that the divisions of

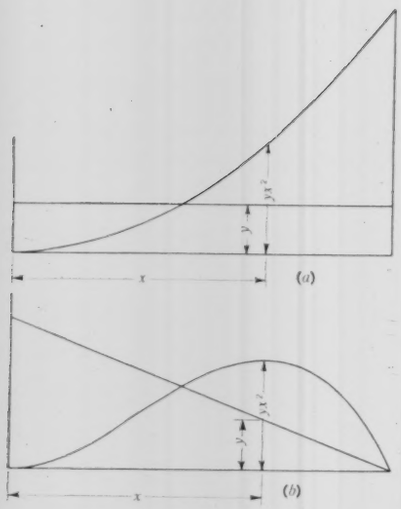

FIG. 5

the triangle have centers at a distance less than x from the axis. In both examples Simpson's rule would give an exact answer.

In many problems double integration may be used in place of single integration, the advantage being that a series of values can be found in the same operation instead of each being found separately. Thus, summing up the loads on a beam gives the shears, and summing up the shears gives the moments. Whenever such a choice exists it can be shown that the difference is simply in the arrangement of the numerical computations, and it is therefore no surprise to learn that any of the foregoing methods of division may be used for double integration. In each case the ordinates of the function are to be multiplied by the factors that appear in Eq. 1, 2, or 3. The first method gives results directly. With the second method it is necessary to interpolate between the results directly obtained. Simpson's rule gives alternately correct and fictitious values.

A Method of Flood Routing

By I. H. STEINBERG

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THE methods ordinarily used in routing floods through reservoirs or reaches of rivers, require, either directly or indirectly, at least two types of curves to determine the desired outflow and storage. One of these is the "outflow-storage" curve, which is the relation between the outflow from the reach and the storage within the reach. The other is usually the "storage-plus-outflow" curve, which is developed directly from the outflow-storage curve. The relation between storage and outflow is often so complex as to require a third variable, or parameter, which gives a family of outflow-storage curves. For each of these curves a corresponding storage-plus-outflow curve must be developed.

A method of routing which requires only one type of curve has been developed by the writer during studies of the 9-ft channel project on the upper Mississippi River. It is particularly applicable to conditions involving complex flow-storage relations, because it eliminates the need for the storage-plus-outflow curve and the attendant additional possibilities for error arising from the greater number of interpolations when two curves are used.

The necessary number of outflow-storage curves are first plotted in the usual manner (Fig. 1). (The parameter in this case, it may be mentioned, is the backwater effect of an important tributary entering downstream from the reach in question.) The "storage-factor" scale, consisting of a family of parallel sloping straight lines, is then constructed. The slope of these parallel lines is dependent upon the time interval used, and the distance between them is dependent upon the unit of length of the storage scale.

The fundamental equation of flood routing is

$$\left(I_1 + I_2\right)\frac{t}{2} + S_1 = \left(O_1 + O_2\right)\frac{t}{2} + S_2 \quad \ldots\ldots [1]$$

where I_1 and I_2 are the initial and final inflow and O_1 and O_2 the initial and final outflow, all in cubic feet per second; S_1 and S_2 are the initial and final storage in day-second-feet; and t is the time interval in days. I_1, I_2, O_1, S_1 are usually known, and O_2 and S_2 are the unknowns which are to be determined.

Transposing the known quantities to the left side of the equation gives

$$\left(I_1 + I_2 - O_1\right)\frac{t}{2} + S_1 = O_2\frac{t}{2} + S_2 \quad \ldots\ldots [2]$$

The left-hand member represents the storage factor, and may be designated by M. If we let t equal 1,

$$M = \frac{O_2}{2} + S_2 \quad \ldots\ldots [3]$$

Equation 3 is the equation of a straight line having two unknowns, a slope equal to -2, and a storage, or S, intercept equal to M. (Note that for a time interval of $t = 2$, the slope would be equal to -1.)

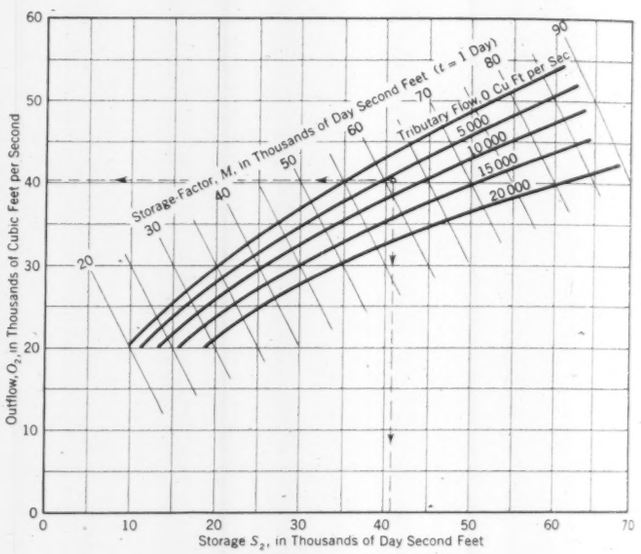
Outflow, O_2, in Thousands of Cubic Feet per Second
Storage S_2, in Thousands of Day Second Feet
Storage-Factor, M, in Thousands of Day Second Feet (t = 1 Day)
Tributary Flow, O Cu Ft per Sec
5,000
10,000
15,000
20,000

FIG. 1. FAMILY OF OUTFLOW-STORAGE CURVES, WITH STORAGE-FACTOR CURVES SUPERPOSED

A definite relation between the storage and outflow for any particular value of the parameter was of course assumed when the outflow-storage curves were constructed. This relation can be represented by

$$S_2 = f\,(O_2) \quad \ldots\ldots [4]$$

and is seen to be the second equation required for the

TABLE I. EXAMPLE OF FLOOD-ROUTING COMPUTATIONS

(1) Day	(2) t Days	(3) I	(4) I_1+I_2	(5) O	(6) $I_1+I_2-O_1$	(7) $(I_1+I_2-O_1)\frac{t}{2}$	(8) S	(9) M (7)+(8)	(10) Tributary Flow
1	1	38,000		43,000			46,000		6,000
			73,000		30,000	15,000		61,000	
2	1	35,000		40,200			40,900		6,000
			66,000		25,800	12,900		53,800	
3	1	31,000		37,800			34,900		5,000
			63,000		25,200	12,600		47,500	
4	1	32,000		35,100			29,900		4,000

solution of the unknowns O_2 and S_2. Equations 3 and 4 when plotted will intersect at a point whose coordinates give the final outflow and storage on their respective scales. The following example illustrates the use of the method.

Assume the conditions for the first day to be: inflow (I_1) = 38,000; outflow (O_1) = 43,000; storage (S_1) = 46,000; tributary flow = 6,000. Further assume that the inflow will decrease to 35,000 and tributary flow will remain constant on the following day. It is required to determine the outflow (O_2) and storage (S_2) for the following day. Therefore t will be equal to one day.

A convenient arrangement for computations is given in Table I. The known, or assumed, quantities are shown in Cols. 2, 3, 5, 8, and 10; Cols. 4, 6, 7, and 9 can be readily computed, which gives the storage-factor, M, equal to 61,000, as shown in Col. 9. With this value of M enter Fig. 1 as indicated and obtain the outflow (O_2 = 40,200) and storage (S_2 = 40,900).

The process is repeated for each succeeding day, using the values determined for the previous day as the starting point. Thus the final inflow, (I_2), outflow, (O_2), and storage, (S_2), for one day become the initial inflow, (I_1), outflow, (O_1), and storage, (S_1), for the following day.

General Formulas for Deflections of Cantilevers

By R. REUBEN KOHN

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THE following general formulas for deflections of cantilevers with varying moments of inertia, for three conditions of loading, are proposed to save time and labor. The ordinary method of laying out an M/EI drawing to scale, rotating the center of gravity of each M/EI area increment about the point where the deflection is required, and then summing up, is both long and

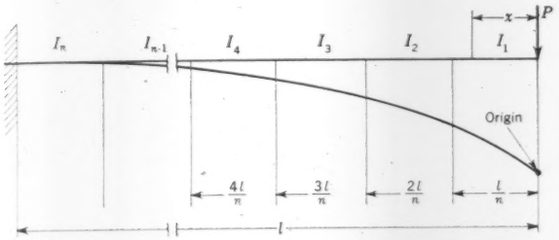

FIG. 1

laborious, and involves a good possibility of error in scaling. This is the graphic solution, whereas the writer's general formulas are the algebraic solutions of the moment-area method. Should unequal divisions be encountered, the general formulas can easily be refigured by changing the limits of the integration.

The example given is an actual flagpole design at Washington, D.C. The errors in assuming the flag as acting at the top, and the uniform load as increasing from zero at the top to a maximum at the bottom, are negligible. The effect of the overlap at the joints is not considered.

A cantilever beam with a concentrated load, P, at the end is shown in Fig. 1. By the moment-area method,

$$\Delta_1 = \frac{1}{EI}\int_0^l M\,x\,dx = \frac{1}{EI}\int_0^l P\,x^2 dx$$

$$= \frac{1}{EI_1}\int_0^{\frac{l}{n}} P\,x^2 dx + \frac{1}{EI_2}\int_{\frac{l}{n}}^{\frac{2l}{n}} P\,x^2\,dx + \ldots + \frac{1}{EI_n}\int_{\frac{(n-1)l}{n}}^{\frac{nl}{n}} P\,x^2\,dx$$

Integrating,

$$\Delta_1 = \frac{Pl^3}{3n^3E}\left[\frac{1}{I_1} + \frac{2^3-1^3}{I_2} + \frac{3^3-2^3}{I_3} + \frac{4^3-3^3}{I_4} + \frac{5^3-4^3}{I_5} + \ldots + \frac{n^3-(n-1)^3}{I_n}\right] \quad [1]$$

If $I_1 = I_2 = \ldots = I_n$, then $\Delta = \frac{Pl^3}{3EI}$, since the first term in the bracket is canceled by the negative term in the second fraction, the first term in the second fraction cancels the second term in the third fraction, and so on, until only $\left(\frac{n}{n}\right)^3$ remains.

By a similar method, the general formula for the deflection of a cantilever with n equal divisions, for a uniform load of w lb per ft (W = total load = wl) is:

$$\Delta_2 = \frac{Wl^3}{8n^4E}\left[\frac{1}{I_1} + \frac{15}{I_2} + \frac{65}{I_3} + \frac{175}{I_4} + \ldots + \frac{n^4-(n-1)^4}{I_n}\right] \quad [2]$$

which reduces to $\Delta = \frac{Wl^3}{8EI}$ if all the I's are equal.

Finally, consider a load increasing uniformly from zero at the free end to $\frac{2W}{l}$ at the fixed end (total load = W). In this case,

$$\Delta_3 = \frac{Wl^3}{15n^5E}\left[\frac{1}{I_1} + \frac{31}{I_2} + \frac{211}{I_3} + \frac{781}{I_4} + \ldots \frac{n^5-(n-1)^5}{I_n}\right] \quad [3]$$

which reduces to $\frac{Wl^3}{15EI}$ if all the I's are equal.

As an example of the use of these equations, let it be required to find the deflection of the top of the flagpole shown in Fig. 2(*a*), which is constructed of sections of extra heavy pipe. The load at the top—that is, the pull of the flag—is 360 lb, and the wind load on the pole is 27 lb per sq ft. Figure 2(*b*) shows how it can be divided into a uniform load, totaling 936 lb, for use in Eq. 2, and a uniformly varying load, totaling 1,170 lb, for use in Eq. 3.

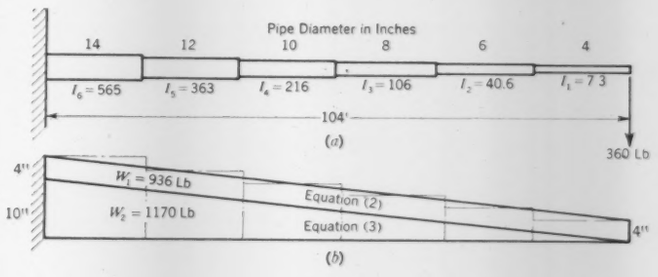

FIG. 2

The total deflection is the sum of the deflections given by Eqs. 1, 2, and 3:

$$\Delta = \Delta_1 + \Delta_2 + \Delta_3$$
$$= \frac{360\times(104\times12)^3}{3\times6^3E}\left(\frac{1}{7.3}+\frac{7}{40.6}+\cdots\right)+$$
$$\frac{936\times(104\times12)^3}{8\times6^4E}\left(\frac{1}{7.3}+\frac{15}{40.6}+\cdots\right)+$$
$$\frac{1{,}170\times(104\times12)^3}{15\times6^5E}\left(\frac{1}{7.3}+\frac{31}{40.6}+\cdots\right)$$
$$= 37.0 + 25.0 + 13.8 = 75.8 \text{ in.}$$

The deflection of the flagpole shown in Fig. 2(*a*), calculated by the moment area method, is 73.9 in. ignoring the lap, and 71.1 in. if the lap is considered as 2 ft 0 in. long and the connection a driving fit. The latter condition may be neglected. The reason the deflection as figured from Eqs. 1, 2, and 3 is greater than 73.9 in., is the assumption that the wind load is distributed as shown in Fig. 2 (*b*). A simple method of correction is to reduce Eq. 2 by 8 per cent. This takes account of the change in moment caused by adding and subtracting equal triangular areas in order to obtain a parallelogram with a uniform load.

Equation 1 may be used in figuring the deflection of a bull-nose girder, or other girder with varying moments of inertia, simply supported, by considering the girder as a cantilever from the reaction to the point where the deflection is required. (This was done on the Frankford elevated structure in Philadelphia, Pa.) Should there be a load on the span between the reaction and the point where the deflection is required, the deflection is that of a cantilever of the reaction about the point, minus cantilever deflection of the load with an overhanging end about the same point.

Equations for Weight Proportioning of Concrete Mixes

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THE 1937 general specifications of the Idaho State Bureau of Highways state that weight proportioning will be required of all concrete materials for structures having an estimated quantity of 200 cu yd or more. This requirement prompted the development of two equations which, though they involve no new principles, have been found to simplify the work of designing the mix:

$$W_c = \frac{27FU}{C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

$$W_f = \left[K - \left(\frac{W_c}{X_c} + M\right)\right]X_f \quad \ldots\ldots\ldots [2]$$

The following nomenclature applies:

- W_c = weight of course aggregate in lb per sack of cement
- F = workability factor
- U = unit weight (dry rodded) of coarse aggregate, in lb per cu ft
- C = number of sacks of cement per cu yd of concrete
- W_f = weight of fine aggregate in lb per sack of cement
- K = a factor dependent on cement content (see Table I)
- X_c = specific gravity of coarse aggregate
- G = number of gallons of water per sack of cement
- M = a factor dependent on water content (see Table II)
- X_f = specific gravity of fine aggregate

As an example, let it be required to design a concrete mix for the following set of conditions: $C = 6.0$, $U = 100.2$, $X_c = 2.90$, $X_f = 2.67$, $G = 6.5$.

TABLE I. VALUES OF K FOR USE IN EQ. 2

C	K	C	K	C	K
4.8	351.0	5.6	300.9	6.4	263.3
4.9	343.8	5.7	295.6	6.5	259.0
5.0	337.0	5.8	290.4	6.6	255.3
5.1	330.4	5.9	285.5	6.7	251.5
5.2	324.0	6.0	280.8	6.8	247.8
5.3	317.9	6.1	276.2	6.9	244.2
5.4	312.0	6.2	271.7	7.0	240.7
5.5	306.3	6.3	267.4		

Assume $F = 0.75$. Further, from Table I, $K = 280.8$; and from Table II, $M = 84.4$. Then, from Eq. 1, $W_c = 338$ lb, and from Eq. 2, $W_f = 214$ lb. The basic mix is 1 sack cement, 214 lb fine aggregate, 338 lb coarse aggregate, and 6.5 gal water. To obtain the field mix, the basic mix must of course be adjusted for absorption and free moisture.

TABLE II. VALUES OF M FOR USE IN EQ. 2

G	M	G	M
5.0	71.9	6.25	82.3
5.25	74.0	6.50	84.4
5.50	76.1	6.75	86.5
5.75	78.2	7.0	88.6
6.0	80.2		

Equations 1 and 2 are based on the assumption that the cement is 48.5 per cent solids. The following additional nomenclature is used in their derivation:

- A = abs. vol. of fine aggregate in cu ft per sack of cement
- b = abs. vol. of coarse aggregate in a unit vol. of concrete
- $b_1 = \frac{U}{62.4X_c}$ = abs. vol. of coarse aggregate in a unit vol. of coarse aggregate
- B = abs. vol. of coarse aggregate in cu ft per sack of cement
- W = number of cu ft of water per sack of cement
- Y = number of cu ft of concrete per sack of cement

Now $F = b/b_1$ by definition. Hence

$$B = 27b/C = 27b_1F/C = \frac{27FU}{62.4CX_c}$$

and $W_c = 62.4X_cB$, or $\frac{27FU}{C}$, as given in Eq. 1.

Further, $Y = 27/C = A + B + W + 0.485$

or $A = 27/C - B - W - 0.485$

and $W_f = 62.4\,X_fA = 62.4\,X_f\left(\frac{27}{C} - B - W - 0.485\right)$

$$= \left[\frac{1{,}684.8}{C} - \left(\frac{W_c}{X_c} + 8.33\,G + 30.26\right)\right]X_f$$

Putting K for $\frac{1{,}684.8}{C}$, and M for $(8.33G + 30.26)$, this reduces to the form of Eq. 2.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Taxing Officials' Salaries

DEAR SIR: Taxing the salary of certain officials of the Port of New York Authority has produced speculation as to the probable future taxation of bonds which finance construction costs of similar revenue utilities operating under charters from both federal and state governments. The U. S. Supreme Court, May 23, 1938, by a five-to-two decision decreed that the salary of the construction engineer and two assistant general managers employed by the Port of New York Authority was subject to the federal income tax. This decision reversed the exemption that the Board of Tax Appeals had granted these officials, based on the supreme court's decision which exempted the salary of the chief engineer of the New York Board of Water Supply (Brush V. Commissioners. 85 Fed (2) 32:300 U. S. Rep. 352).

Mr. Justice Stone, in writing the majority opinion in the Port Authority case, stated that the precise question before the court had never received a ruling (Helvering V. Gerhardt. May 23, 1938: U. S. Docket 779). The terse explanation of the exemption of the chief engineer of the Board of Water Supply rests on the ruling that he was a statutory official of New York State. The officials taxed as employees of the Port Authority were held not within this privilege of exemption as their services were performed for a corporation which was in legal effect an independent contractor.

The Port Authority is a bi-state organization authorized by the states of New York and New Jersey in 1921 to acquire and operate any terminal or transportation facility within a specified area. Its property and bonds are tax exempt because it is a governmental agency of the states mentioned. It is not operated for profit as are many water works that are owned by a city and sell surplus water to private consumers. Congress recognized the Port Authority, July 1922, as performing a governmental function in expediting postal, military, and other services of vital importance to the nation.

This decision of May 23 carries dictum in the majority opinion which two dissenting justices termed as overturning precedents of more than a century. Not only are the salaries of thousands of engineers employed on similar revenue projects brought up for review because they have heretofore been allowed exemption under rulings of the Board of Tax Appeals, but there is the uncertainty of substantial taxation attending the sale of bonds to finance construction of municipal engineering projects which are essentially revenue-producing utilities. These will be financed with federal money as loans or gifts, but the construction cost will include a possible tax levied by the state or federal government. This cost includes the sale of bonds as part of the actual cost of doing business as well as salaries of operating officials (James V. Dravo Contracting Co. 302 U. S. Rep. 134: Dec. 6, 1937). The supreme court in its Authority decision has departed from the academic relation of all expenses incurred on revenue projects by a government and holds as taxable those operations and salaries which the court deems independent of usual government activities and which could be performed as well by private enterprise. The court cites numerous decisions it has reached in holding as subject to the federal income tax, moneys received as income or profit from performing services for the state as an independent engineering contractor (Metcalf & Eddy V. Mitchell. 269 U. S. 514).

Civil engineers are variously employed, now, on many federal and state construction projects. Thirty-four states have income tax laws, and the attorney-generals of three states have gone on record that many employees of federal agencies are not immune from state income taxes (*The Bond Buyer*. April 9, 1938). It will be advisable for the engineer in charge of construction of new revenue utilities authorized by municipal corporations to investigate this feature of taxing income or profits as directly related to engineering costs.

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Short Cuts in Squaring Numbers

TO THE EDITOR: I note on page 271 of the April issue of CIVIL ENGINEERING a short article on "Simplified Squaring of Numbers" by Courtney L. Stone, Jun. Am. Soc. C.E. A similar short cut for general multiplication is as follows:

Reduce the two numbers to the forms of $(A + B)$ and $(A + C)$, respectively. Then their product is $A^2 + A(B + C) + BC$. The value of A should be less than the smaller of the two numbers to be multiplied; preferably also it should end in a cipher so that it can be squared easily from memory.

For example, 67×74 can be split into $(60 + 7)(60 + 14)$, and the product is $60^2 + (7 + 14)60 + 7 \times 14$. This method can be used for quick squaring of any number under 100 without the use of the tables; for squaring, of course, $B = C$. Should the number end in 5 the product should be $A(A + 10) + 5^2$; hence to square any number (preferably under 100) ending in 5, multiply the tenths digit by the next higher digit and add 25. Thus $65^2 = 60 \times 70 + 25$.

N. A. CARLE, M. Am. Soc. C.E.

Seattle, Wash.

Florida's Surface Water Supplies

TO THE EDITOR: Mr. Pirnie's article on "Treatment of Florida's Artesian and Surface Water Supplies," which appeared in the May issue, brings out the salient differences between Florida's raw waters procured from surface sources, and those procured from underground aquifers.

The article also includes a study of the geographical location of underground supplies from the Ocala stratum with reference to their sulfate content; this study is very helpful in recommending types of treatments to be investigated in any particular section of the state. However, a raw water with a high sulfate content, per se, is not always a costly water to treat, particularly where it is to be used by a municipality, or a paper mill whose boiler feedwater requirements are of minor importance. At Sarasota (sulfates as SO_4, 832 ppm) the entire treatment and maintenance costs amount to only $14 per million gal—for producing a 6-grain effluent from a 68-grain influent.

Mr. Pirnie makes the statement that excessive drawdown of existing artesian wells is dangerous because of the possibility of an increase in sulfate content. He then goes on to say that in areas of low ground-water movement (that is, stagnant areas) waters high in sulfates are found, which seems to me to be rather a contradictory set of conditions.

His concept of the danger of salt-water intrusion into excessively drawn-down artesian wells is not qualified in any way, and to my mind such qualification is necessary. Danger from salt-water intrusion into artesian wells in Florida, penetrating such surficial rock strata as the Hawthorn, Ojus, and Oolite, may be present in some localities, but properly cased artesian wells penetrating into the Ocala stratum in various localities have remarkably good records extending over a period of years.

The city of Jacksonville (municipal supply) has had a practically unvarying chloride content from its wells (in the Ocala stratum) over a period of fifteen years, although the draft on the underground source has steadily increased during this period.

Wells recently drilled into the Ocala strata for various new paper and pulp mills constructed in north Florida and south Georgia indicate the presence of highly impermeable layers in the Ocala rock, and these layers successfully seal off the water in one level from that in the next above or below. Such impermeable layers will prevent or greatly retard the intrusion of saline water into fresh supplies lying above it. The reasons given by these paper mills for using artesian wells in the Ocala stratum as sources of raw water were dependability of supply, ease of procurement, and low cost of treatment where the industries are located at or near tidewater.

CHARLES E. RICHHEIMER, Assoc. M. Am. Soc. C.E.

Jacksonville, Fla.

The Engineering Profession and Social Problems

TO THE EDITOR: I am grateful to Messrs. Hanrahan and Higgins for their constructive and interesting discussions of my article, "Social Horizons of the Engineer," which appeared in the November issue of CIVIL ENGINEERING.

In the January issue, Mr. Hanrahan contributes some valuable data on timber growth in this country and emphasizes the fact that timber is a renewable resource, which may ultimately be grown in sufficient quantity to meet our annual demand. Following present procedure, our timber supply will last 74 years; with anticipated improved procedure it will last 204 years; and if further improvements are made in the meanwhile, we may expect to grow annually as much timber as we consume before the end of these two centuries. Mr. Hanrahan, however, agrees that probably two-fifths of our original timber supply was completely wasted by burning and other means; and the fact that this resource is still on the decline, and is expected to be on the decline for a considerable time to come, should be cause for concern. It is an especially serious matter because our forest areas play such an important part in the maintenance of our land against floods and soil erosion. And it is significant that the leadership toward renewal of these timber supplies usually devolves upon society, although the original waste or use for profit was by private interests.

Mr. Higgins, in his discussion in the April issue, gives a fine presentation of the Henry George school of thought in economics. It is true that many of our ills would be cured if land were owned by society, and that a tremendous amount of land rentals go into the unearned income which takes away from the purchasing power of the majority of the people. I am in favor of the ultimate public ownership of land. But I think that Mr. Higgins underestimates the importance of capital plants in industry today, for even if land were readily available (presumably with rental on it paid to the government as a tax) it would be futile for new interests to attempt competition in a small way with some of the large industries now existing. So while public ownership of land is important, I cannot agree that it alone would cure all our ills. Civilization is too complicated today, and the means of exploitation are too varied, to permit a single panacea to be effective.

If, however, the engineering profession generally begins to analyze the society which its work so clearly influences, we may finally reach the solution of our economic troubles.

HARRY J. ENGEL, Assoc. M. Am. Soc. C.E.

Harrisburg, Pa.

Fine Highways in Mexico

DEAR SIR: In his article, "Development of Highways in Mexico," in the March issue, Ricardo L. Vázquez has presented a most interesting picture of road building in Mexico, from both the historical and technical viewpoints. He has shown the great advances that Mexico has made in developing her highways despite the obstacles which the terrain and local governmental problems presented.

Last December it was my privilege to be in Mexico. Since my visit was solely for pleasure, I did not look upon the country and its problems with the eyes of a native engineer, but rather considered it from the viewpoint of a visitor. Even as such, I was very much impressed with the remarkable highways, in spite of the general opinion in the United States that good roads are rare in Mexico. Before landing at Vera Cruz, I had been told many conflicting stories regarding transportation to Mexico City. Finally I went by rail to Orizaba, thence by hired automobile to Mexico City. It was a happy chance that I selected this mode of transportation; otherwise, I would have missed much of the glorious scenery from Orizaba to Mexico City, to say nothing of the comfortable trip over this modern highway. The road from Orizaba to Mexico City, which goes through Tehuacan and Puebla, is what would be termed a "first class" road in the United States. But there the comparison ends! A road, in itself, may be comfortable to motor along, but the highly interesting local color along Mexican highways—innumerable cathedrals and snow-capped Popocatepetl and Ixtaccihuatl—is rarely equalled along our own highways and adds to the joy of traveling.

After a few days in Mexico City an unusual incident occurred. While strolling in Alemeda Park I approached a well-dressed native and asked for some information. During our conversation he noticed I was wearing the Society emblem and said "My son belongs to that up in New York." When he learned that I came from New York, he naturally was interested. He said that his son was a Student Chapter member in New York and that he had attended high school there—and it proved to be the same high school from which I had graduated! Incidentally, I later met the son at a meeting of the Junior Branch of the Metropolitan Section of the Society in New York. All this illustrated to me how small this world really is and how far our Society fellowship extends.

From Mexico City to the United States I motored along the new, modern, and beautiful Mexico City–Laredo Highway. This highway, which is a through road, all "first class" for a distance of about 750 miles, is bituminous macadam, protected by sturdy, modern guard rails. These guard rails are very important, for the route is mountainous and requires numerous curves in the road and sharp drops at the shoulders in many places. The accompanying photograph, taken along this road, illustrates the type of guard rail used and also shows the terrain and landscape.

While traveling over the Mexico City–Laredo Highway, I was impressed with the problems that the construction of the road must have presented. Señor Vázquez, in his paper, confirms my impression. The road could not be built like so many of our "express highways," with long straight sections and wide angle curves. The mountainous terrain, requiring many sharp curves in the road, naturally limits the speed of travel, but that is not a drawback in such a picturesque region.

In conclusion, I should like to congratulate the Mexican government on its advancement in modern highway construction. I sincerely feel that for a beautiful and pleasant trip Mexico offers a first-class choice.

GEORGE J. VIERTEL, Jun. Am. Soc. C.E.
Construction Superintendent,
New York, N.Y. *M. Shapiro and Son*

TWO SCENES ALONG THE MEXICO CITY–LAREDO HIGHWAY
The View at the Left Was Supplied Through the Courtesy of Señor Vázquez and the Direccion Nacional de Caminos

The First Board Dinner

DEAR SIR: On page 217 of the March 1938 issue of CIVIL ENGINEERING, is recounted the first meeting of the "Past and Active Officers' Dinner" of the Society under the present plan. My recollection goes back to the first dinner given by the Outgoing Board to the Incoming Board, which ultimately developed into the present practice.

It was in 1900—my first year on the Board—when the first meeting of the kind was held. About a dozen of the Directors sat about a round table, in a "get together" spirit. As the dinner progressed, the speeches usual on such occasions were called for and had gone the round of the table when C. W. Buchholz, my active chief, noticed that I had been omitted and called attention to the fact. I was never a speaker and had been glad to be overlooked.

Having no speech to make, I arose to my feet in a tremor and could only repeat an Arab Proverb which I had recently learned:

"He who knows not, and knows not that he knows not, is a fool. Shun him.

"He who knows not, and knows that he knows not, is simple. Teach him.

"He who knows, and knows not that he knows, is sleeping. Wake him.

"He who knows, and knows that he knows, is an Engineer. Follow him."

By substituting "an Engineer" for the customary "a wise man" of the proverb, I brought down the house and was pronounced "an able speaker." Thus the dinner was impressed upon my memory.

HENRY B. SEAMAN, M. Am. Soc. C.E.

Brooklyn, N.Y.

Rules for Job-Getting

DEAR SIR: Having some forced leisure on hand on account of the present recession, I have found time to study Walter L. Fitzgerald's article on "Putting the Best Foot Forward," appearing in the March issue. Mr. Fitzgerald presents in condensed fashion a number of familiar "do's and don't's," not unlike the adviceg iven by Dale Carnegie, Edward Hurst, Napoleon Hill, Robert Collier, and a host of other specialists. Although Mr. Fitzgerald differs but little from the others in his actual advice, he omits the usual mysticism and suspense mechanics in which the others delight to indulge.

Why not all agree on three simple rules of job-getting: (1) Present a good appearance (who cares for a slovenly person anyhow?); (2) go "in high" with your personality (it works); and (3) present your prospective boss with the dotted line and a fountain pen full of ink. Ask any salesman if this is not good sense.

During the depression I was caught napping. Since then, many kinks in this matter of personality have been ironed out. Some still need a great deal more ironing. And that's rightly my personal job.

However, here's a phase of the problem which no doubt affects many of us, and yet the specialists (Mr. Fitzgerald included) either minimize or omit the issue entirely. Let me pose the question by presenting my own case. I am a structural designer with major experience in concrete, and have dealt with a great variety of types of structures—but not all types. In the past two months several leads in that field were unearthed, but I was rejected as a reinforcing bar detailer because of no "bar company" experience, and as a designer of concrete and steel because of no shipyard experience.

As concrete jobs are so scarce the following other fields have been investigated: (1) Research in scientific, low-cost housing (a most timely field); (2) aeronautical stress analysis; (3) ship design (the new naval and merchant marine program); (4) chemical and oil plant pipe layout (there appears a scarcity of "pipe" men); and (5) the WPA. The unanimous reason given for rejection was "no experience."

Mr. Fitzgerald cautions the job-seeker to first answer, in his own mind, the employer's question, "What *can* you do?" In times like the present, few indeed are the employers who ask such a question in any form. The employer well knows what he wants. He simply asks, "What has been your experience in such and such a line?"

In a recent sermon on unemployment, Dr. John Haynes Holmes, liberal minister of the Community Church, New York City, gave the following counsel to the unemployed. Hunt a job—anything at all. That failing, make a job—an enterprise of one's own. That failing, apply for relief.

Like so many other engineers, I have faith in my talents and abilities above and beyond that which the average employer is willing to admit. In the light of the first and second points of Dr. Holmes' suggested program, what possible modus operandi is available to the "outs"? This is a bid for a frank, intellectually honest expression of opinion on this whole question, looking toward positive, realistic ways of solution. Let's hear from all who have ideas—but especially from employers, personnel experts, and all others who are on the "inside."

W. EDWIN THOMPSON, Assoc. M. Am. Soc. C.E.

Brooklyn, N.Y.

The Weather Map

TO THE EDITOR: The amount of scientific observation that enters into the making of the weather map is but little known or appreciated by the average reader, although it is the one picture published in certain newspapers every day in the year. At any rate, the civil engineer should understand the weather map, and after reading Mr. Gregg's article, in the May issue, I am tempted to comment on the use of such maps.

The temperature at different points is given on these maps. A series of continuous lines, the isobars, pass through points of equal barometric pressure (reduced to sea level). "Arrows fly with the wind." Wind is air in motion, and the causes that lead it to take directions shown by the arrows are seldom understood. "It must be remembered that the distribution of pressure causes forces which push the air from high pressure to low, and perhaps a natural view is that the air moves in the direction in which the pressure is pushing it, but however natural it may be, it is erroneous." So writes Sir Napier Shaw, that prince of meteorologists. It will be noticed that on the map the isobars are curvilinear. Now, curvilinear motion can come only from the action of a continued constant force whose direction differs from that of the original impulse. This means that if any body is moving along a curve path, a deflection force is always perpendicular to the path and directly towards the center of curvature. This deflective force is the barometric pressure gradient, indicated by the rise or fall of the barometer in passing from one region to another.

There is a deflection due to the earth's rotation. This is exceedingly important in any study of the wind. To quote from Blair's *Weather Elements*, "The deflective influence of the earth's rotation causes the air to follow a path curved with reference to the earth, and thus brings into play a centrifugal force resulting from the curvature and acting outward from the center of curvature."

At a certain distance above the earth's surface (perhaps 1,500 ft), where friction and local conditions are not felt, these forces balance the force pushing the air between isobars. This causes a steady unchanging wind, known as the gradient wind, which has been defined as "that wind which in a particular latitude is in dynamical equilibrium under the action of forces due to the barometric pressure gradient, the rotation of the earth, and the curvature of the path in which the wind moves." With a change in direction but not in speed, the velocity is non-fluctuating and is known as the gradient velocity. "Gradient wind" and "gradient velocity" are favorite terms with the meteorologist. However, the arrows on the weather map show the direction of surface winds taken from actual observations.

The subject of wind study is quite complex. Attention is called to a scholarly treatise, *Physical and Dynamical Meteorology*, by Prof. David Brunt, of the University of London (The Macmillan Company, New York City). A simpler but excellent treatise, dated 1937, is *Weather Elements, a Text in Elementary Meteorology*, by Thomas A. Blair, senior meteorologist of the U. S. Weather Bureau (Prentice-Hall, Inc., New York City).

ROBINS FLEMING

New York, N.Y.

Subscriber on the Defensive

DEAR MR. EDITOR: You have started something!

Last night I mildly suggested to the better half that it was time to retire and was told to wait until she completed her perusal of the magazine she was studying. I asked what she was looking at, and she said "CIVIL ENGINEERING; and I notice that you can get quick-setting concrete by using 7 sacks of cement as against $5\frac{1}{2}$ sacks of ordinary cement; and just what kind did they use in building that concrete wall which we had so much trouble in teardown?" I merely answered, "Yes, Ma'am," to conceal my ignorance.

After a lapse of a few minutes I was informed that welding steel structures seemed to be gaining and was preferable in the case of the hospital cited. I answered again, "Yes, Ma'am."

I can now see that this publication takes its place alongside the *Woman's Home Companion* and *Good Housekeeping*, and it behooves me to read it carefully before allowing it to get into home circulation.

C. E. BOWRON, M. Am. Soc. C.E.
Consulting Engineer

Birmingham, Ala.

Beauty in Modern Bridge Structures

TO THE EDITOR: As pointed out by Mr. Watson in his article on "Architectural Principles of Bridge Design," in the March issue, there are different conceptions of what constitutes beauty in bridges and, correspondingly, there are different methods of attaining it. Each method is a valid contribution, and all need to be considered by the designer.

It is agreed that the "17 Arch Bridge" at the Summer Palace of the former Dowager Empress near Peiping is an artistic gem. The tapering series of arches in this structure delights the eye from every angle. Here beauty has been obtained through the fundamental principle of rhythm, involving repetition, gradation, and harmony. It is a rhythmic succession of beautiful notes—all combined in a melodic and harmonious composition.

Another conception of beauty is typified by the Alexander III Bridge over the Seine at Paris, a steel-arch span of graceful proportions. In this case beauty has been interpreted in terms of decoration, and the architectural treatment consists of statuary, sculpture relief, and applied ornamentation.

Still another conception of beauty is represented by the Landwasser Viaduct of the Albula Railroad in Switzerland. Here beauty is obtained through utmost simplicity of line combined with boldness of proportion and magnitude.

In each of the structures mentioned, the design is harmoniously appropriate to its setting and expresses the artistic spirit of its location. The three examples typify what may be designated as poetic, artistic, and functional beauty, respectively. No single one of these is the complete or universal solution.

In general, the following elements should be considered by the bridge designer: Harmony with environment, internal harmony, composition, symmetry, honesty, simplicity, grace, proportion, gradation, emphasis, framing, punctuation, rhythm, repetition, alternation, inflection, relief, contrast, continuity, interest, scale, light and shadow, color, and illumination.

Masonry architecture has been developing for over 2,000 years, but the same fundamental principles govern the attainment of beauty in steel structures. Even in small truss bridges, an effect of beauty is obtained by selecting a pleasing web pattern (as by using a double, instead of a single, triangular system, producing an alternation of diamonds and verticals) and then applying such pattern in rhythmic repetition. The Innsbrueck Bridge is an example of this type of structure.

The deck arch is the simplest and most naturally pleasing type of steel span for esthetic design, because of its functional clarity. As typified in the Henry Hudson Bridge, shown in the accompanying photograph, it yields a dominant, clear roadway line carried on the graceful curve of the supporting arch.

For beauty of composition in steel bridge design, the suspension type, well illustrated in the St. Johns Bridge at Portland, Ore., is ideal. A view of this bridge appears here. The graceful curve of the cables is the most beautiful of all bridge outlines, and the vertical hangers are the most satisfying form of filling members. The lightly arched roadway line is clear and continuous from shore to shore, and tall, graceful towers divide the crossing into three spans of artistic proportion.

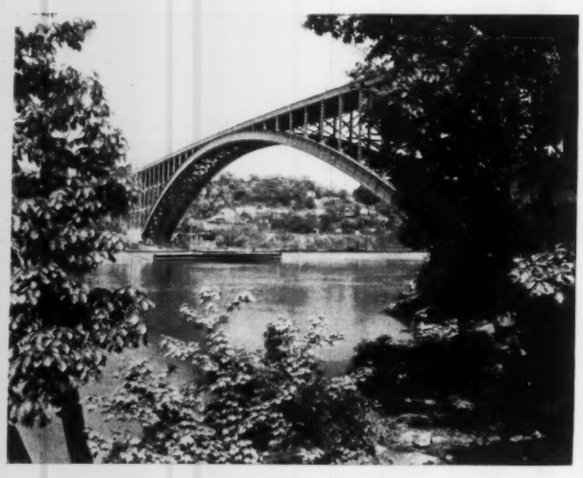
The tower portal of the St. Johns Bridge is an example of true architecture in structural steel. Here, practically nothing has been added for ornament or decoration; there is no camouflage, no concealment, and everything visible is structural steel. Not a single pound of metal was wasted, and all was designed for maximum efficiency. Nevertheless, the entire construction was planned to produce beauty of line and form and to express the spirit of structural steel—its strength, its power, and its grace.

The towers of suspension bridges are dominant and should be designed for grace and beauty. For instance, in the towers of the Mount Hope Bridge, shown in the accompanying photograph, the bracing has been treated to yield an artistic composition, with lofty arched portals above the roadway. The lines of these portals harmonize with the lines of the cable—in point and counterpoint. In the towers of the Waldo-Hancock Bridge, in Maine, a beautiful effect is secured through the use of parallel lines and patterns arranged in rhythmic alternation and repetition, with harmonious spacing and proportions.

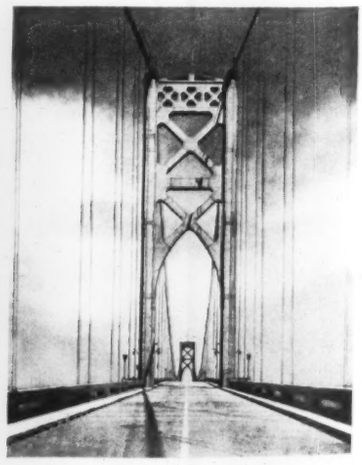
D. B. STEINMAN, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.

The St. Johns Bridge, Portland, Ore.



The Henry Hudson Bridge, New York City



Mount Hope Bridge, Bristol, R.I.

BEAUTY IN MODERN BRIDGE DESIGN IS EXEMPLIFIED IN THESE STRUCTURES

BURLINGTON ZEPHYR

Sixty-Eighth Annual Convention

Salt Lake City, Utah, July 20–23, 1938

Hotel Utah to Be Headquarters

Opening Session and General Meeting

WEDNESDAY—July 20, 1938—Morning

9:00 **Registration**

10:00 **Convention called to order by**

R. A. HART, *President, Utah Section, Am. Soc. C.E.; Civil Engineer Member, State Board of Health; Assistant Director, Public Relations, Denver and Rio Grande Western Railroad*, Salt Lake City, Utah.

10:05 **Address of Welcome**

HIS HONOR, JOHN M. WALLACE, *Mayor of the City of Salt Lake City*, Utah.

10:20 **Response**

HENRY E. RIGGS, *President, American Society of Civil Engineers; Honorary Professor, Civil Engineering, University of Michigan*, Ann Arbor, Mich.

10:25 **Annual Address**

HENRY E. RIGGS, *President, American Society of Civil Engineers.*

SYMPOSIUM ON TRANSPORTATION

11:15 **Review of Advances in Transportation**

FRED LAVIS, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

Business Meeting and Luncheon Recess

WEDNESDAY—July 20, 1938—Afternoon

CONTINUATION OF SYMPOSIUM ON TRANSPORTATION

Rail Transportation

2:30 **Light-Weight Diesel Electric Trains**

RALPH BUDD, *M. Am. Soc. C.E., President, Burlington Lines*, Chicago, Ill.

3:00 **Diesel and Turbo Electric Light-Weight Trains**

C. P. KAHLER, *Assoc. M. Am. Soc. C.E., System Electrical Engineer, Union Pacific Railroad*, Omaha, Nebr.

3:20 **Highway Transportation**

L. I. HEWES, *M. Am. Soc. C.E., Deputy Chief Engineer, U. S. Bureau of Public Roads*, San Francisco, Calif.

3:40 **Air Transportation**

SPENCER B. NEWMAN, *District Manager, United Air Lines*, Salt Lake City, Utah.

4:00 **General Discussion**

MURRAY SULLIVAN, *M. Am. Soc. C.E., General Manager, Salt Lake and Utah Railroad*, Salt Lake City, Utah.

WEDNESDAY—July 20, 1938—Evening

7:00 **Dinner and Entertainment—Hotel Utah**

Toastmaster: R. A. HART, *President, Utah Section, Am. Soc. C.E.*

Speakers: HEBER J. GRANT, *President of the Church of Latter Day Saints* on "Reminiscences."

RANDALL L. JONES, *Special Representative of the General Manager, Union Pacific Railroad*, on "Southern Utah Scenery" (illustrated).

Tickets for the dinner and evening's entertainment are $2.50 each.

Sessions of Technical Divisions

THURSDAY—July 21, 1938

SURVEYING AND MAPPING DIVISION

Morning

9:30 Status of Mapping West of the Mississippi River

WILLIAM BOWIE, *M. Am. Soc. C.E., formerly Chief, Division of Geodesy, U. S. Coast and Geodetic Survey,* Washington, D.C.

10:00 Status of Mapping in Utah and Adjoining States

RALF R. WOOLLEY, *Senior Hydraulic Engineer,* and GEORGE H. TAYLOR, *Assoc. M. Am. Soc. C.E., Associate Hydraulic Engineer, U. S. Geological Survey,* Salt Lake City, Utah.

10:30 Aerial Mapping in Soil Conservation

W. C. LOWDERMILK, *Chief, Soil Conservation Research, U. S. Soil Conservation Service,* Washington, D.C.

11:00 Stereographic Mapping

W. S. HIGGINSON, *Engineer, U. S. Geological Survey,* Salt Lake City, Utah.

Photo by U. S. Forest Service

AIR VIEW OF ONE OF THE FLOODED CANYONS, DAVIS COUNTY, UTAH, SCENE OF SATURDAY TRIP

IRRIGATION DIVISION

Morning

9:30 The History of Irrigation in Utah

O. W. ISRAELSEN, *M. Am. Soc. C.E., Professor of Irrigation and Drainage Engineering, Utah State Agricultural College,* Logan, Utah.

10:00 Development of the Colorado River System in the Upper Basin

T. C. ADAMS, *Assoc. M. Am. Soc. C.E., Associate Professor, Civil Engineering, University of Utah,* Salt Lake City, Utah.

10:30 The Deer Creek Project

E. O. LARSON, *Engineer, U. S. Bureau of Reclamation,* Salt Lake City, Utah, and E. A. JACOB, *M. Am. Soc. C.E., City Engineer,* Provo, Utah.

11:00 General Discussion

12:00 Luncheon Recess

IRRIGATION DIVISON

Afternoon

2:30 Report on the Activities of the Committee on Conservation of Water

H. F. BLANEY, *M. Am. Soc. C.E., Irrigation Engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture,* Los Angeles, Calif.

3:00 Relation Between Flood Control and Water Conservation

L. M. WINSOR, *M. Am. Soc. C.E., District Engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture,* Salt Lake City, Utah.

3:30 Drainage of Irrigated Lands

A. W. WALKER, *Assoc. M. Am. Soc. C.E., Superintendent, U. S. Bureau of Reclamation,* Fairfield, Mont.

4:00 Present-Day Methods of Irrigation Development in China

O. J. TODD, *M. Am. Soc. C.E., Consulting Engineer,* Claremont, Calif.

4:30 General Discussion

LIBERTY PARK, SALT LAKE CITY; WASATCH MOUNTAINS IN BACKGROUND

ccupy the Entire Day

THURSDAY—July 21, 1938

HIGHWAY DIVISION

Morning and Afternoon

9:30 **Highway Planning**

C. B. McCULLOUGH, *M. Am. Soc. C.E., Assistant State Highway Engineer, State Highway Commission*, Salem, Ore.

10:00 **State-Wide Highway Planning Survey**

A. C. SPAN, *Bureau Manager, U. S. Bureau of Public Roads, District No. 12*, Salt Lake City, Utah, and LEE WENDELBOE, *Assoc. M. Am. Soc. C.E., Engineer, Utah State Road Commission*, Salt Lake City, Utah.

12:00 **Luncheon Recess**

2:30 **Highways from the Users' Standpoint**

CHESTER H. GRAY, *Director, National Highway Users Conference*, Washington, D.C.

3:00 **Part Played by Highways in Recent California Floods**

F. W. PANHORST, *M. Am. Soc. C.E., Bridge Engineer, State Division of Highways*, Sacramento, Calif.

3:30 **Lyman System of Street and Highway Numbering**

GEORGE M. HALEY, *County Surveyor, Salt Lake County*, Utah.

SANITARY ENGINEERING DIVISION

Afternoon

2:30 **Sewage and Garbage Disposal—Needs of the Western States**

DANA E. KEPNER, *Assoc. M. Am. Soc. C.E., Hydraulic and Sanitary Engineer*, Denver, Colo.

3:00 **Sewage Disposal at Denver, Colo.**

E. B. BLACK, *M. Am. Soc. C.E., Consulting Engineer*, Kansas City, Mo.

3:30 **Modern Incinerator Practice**

HARRISON P. EDDY, JR., *M. Am. Soc. C.E., Consulting Engineer*, Boston, Mass.

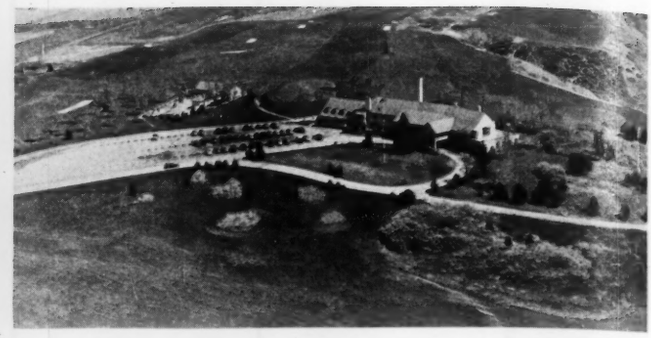
WINDOW IN 6,500-FT TUNNEL ON ZION–MT. CARMEL HIGHWAY, SOUTHERN UTAH

THURSDAY—July 21, 1938—Evening

7:00 Dinner, Informal Evening, Dancing—Empire Room, Hotel Utah

Tickets for the dinner and evening's entertainment are $2.00 each.
There will also be arrangements for bridge for those who wish to play cards.

RESIDENTIAL DISTRICT, SALT LAKE CITY



SALT LAKE CITY COUNTRY CLUB

Entertainment for the Ladies

WEDNESDAY—July 20, 1938

Morning and Afternoon

Shopping Tours, Visits to Church Office Building, Temple Square, State Capitol Building

The Ladies Committee has planned a number of short trips for the entertainment of the ladies, including visits to Salt Lake City's stores, Church Office Building, Temple Square, and State Capitol Building.

These trips may be taken as convenient to the visitors and will start from the Hotel Utah. Cars and guides will be available.

Salt Lake City has many points of interest to visitors. The Church Office Building provides a very interesting trip and likewise the museum in Temple Square. The State Capitol Building is unique in the scope and arrangement of its exhibits.

Evening

7:00 Dinner and Entertainment

Ladies will join the members for the dinner and entertainment at the Hotel Utah.

THURSDAY—July 21, 1938

Morning and Afternoon

Sightseeing Trip Through Residential Section, with Luncheon at the Salt Lake City Country Club, Returning in the Afternoon for a Special Organ Recital at the Tabernacle at 4:30 p.m.

Ladies will leave the Hotel Utah at 11:30 a.m. for a comprehensive tour of the more important points of interest in and around Salt Lake City, including Wasatch High Line Drive, parks, boulevards, and residential district.

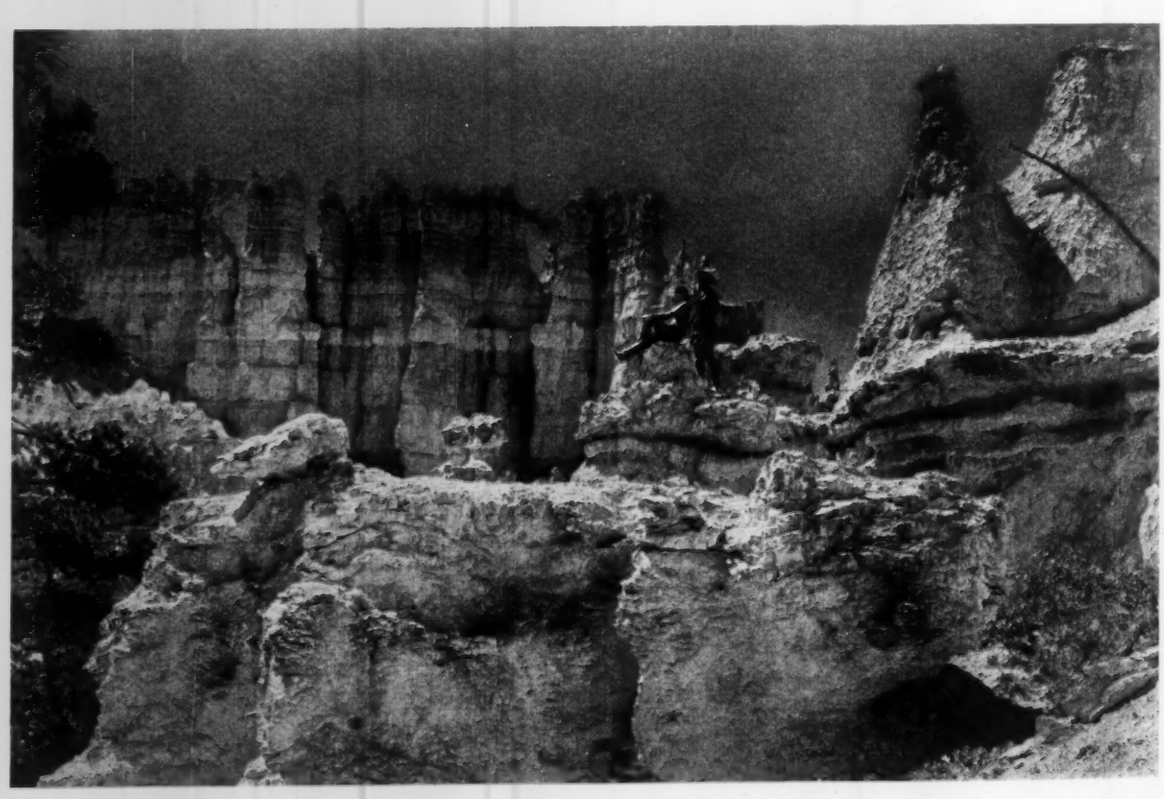
The excursion will stop at the Salt Lake City Country Club for luncheon, which will be served about 1:00 p.m.

The party will return to Salt Lake City for a special organ recital in the Mormon Tabernacle at 4:30 p.m.

Evening

7:00 Dinner and Informal Dance

Ladies will join the members for the dinner and entertainment at the Hotel Utah.



Union Pacific Railroad Photo

WALL OF WINDOWS, BRYCE CANYON NATIONAL PARK, UTAH

THE WORLD'S LARGEST OPEN-CUT COPPER MINE AT BINGHAM, UTAH

Excursion to Bingham Copper Mines and Copper Mills and Garfield Flood Control Works

FRIDAY—July 22, 1938—All Day

10:00 Members, ladies, and guests will leave the Hotel Utah at 10:00 a.m. sharp for a visit to the new highway tunnel and the great open-pit copper mines at Bingham. The excursion will then proceed by the copper mills at Garfield and Arthur, stopping for luncheon at the Club House of the Utah Copper Company at Arthur.

Following luncheon, the party will visit the smelters at Garfield and the flood control project near the smelters.

The party will go by motor to a lookout point where a bird's-eye view may be had of the system of flood control which is now near completion. Those interested will have the opportunity of viewing the works in detail.

In 1927, an unprecedented flood damaged or destroyed a considerable portion of the Garfield Smelter. The present system of control works was started immediately after the 1927 flood, and has provided complete control.

An outstanding feature is a barrier one mile long across the mouth of the canyon, above which the flood stream is forced to spread out and unload its burden of boulders and mud before it passes over a massive spillway of rubble masonry 100 ft high. A second barrier of similar proportions, together with other pertinent structures, is now in process of construction.

The district and plant engineers will be on hand as guides, and the engineer who planned and designed the control system will also be with the party.

After the inspection of the smelters, the excursion will proceed to Saltair on Great Salt Lake, arriving about 4:30 p.m., in time for bathing on the lake.

Dinner may be had at the Saltair Pavillion, or those who prefer may return to Salt Lake City for dinner.

In returning to the city from Saltair, the excursionists will pass the salt works, the Salt Lake municipal airport, and the fair grounds where the rodeo show of the Pioneer Days Celebration will be held in the evening.

Tickets for the trip, including luncheon, are $5.00 each.

Seats Have Been Reserved on Friday Evening for the Rodeo Show of the Pioneer Days Celebration. Consult the Registration Desk for Information and Prices.

CONCRETE FLOOD SCREEN ABOVE BINGHAM SMELTER

FLOOD SCREEN AFTER THE 1937 FLOOD

Trips to Points of Engineering Interest

SATURDAY—July 23, 1938

Inspection Trips

Arrangements have been made for visits to the following engineering works:

(1) **Davis County Watershed Tour, Including Inspection of Destructive Mud-Rock Flows and Flood Control Operations** (No charge except 50 cents for luncheon)

(2) **Pine View Dam and Ogden River Irrigation District** (Tickets for this trip are $3.50, not including luncheon)

In order to make the necessary transportation arrangements, members are requested to signify their intention of taking these trips at the time of registration.

DAVIS COUNTY WATERSHED TOUR, INSPECTION OF DESTRUCTIVE MUD-ROCK FLOWS AND FLOOD CONTROL OPERATIONS

Other Items of Interest Include View of Great Salt Lake from Nearly Two-Mile High Scenic Road, Artificial Reseeding Trials, and Experimental Range Watersheds

The party will leave Hotel Utah promptly at 9:00 a.m. and proceed north via the Salt Lake–Ogden Highway to the Transient Camp, providing a panoramic view of Great Salt Lake to the west, and the Davis County communities at the base of the steep Wasatch Mountains to the east.

The excursion will then proceed through the Davis County communities along the base of the Wasatch Front for an inspection of the spectacular and destructive mud-rock flows. During the period 1923 to 1932, this area suffered flood damages to the extent of $1,000,000.

Following an inspection of the flood scene, debris basins and barriers, the caravan will inspect the flood sources and the watershed management measures being applied to control this menace.

These flood and erosion control operations were initiated in 1933. Since then, work on five of six flooding canyons has been completed, and work on the sixth is nearing completion.

After traversing the headwaters of the five controlled watersheds and inspecting batteries of experimental runoff plots and artificial reseeding plantations, the excursion will proceed into Farmington Canyon for luncheon at the CCC camp, and for a first-hand inspection of contour trench operations.

Following this inspection, the party will descend to the valley via the newly opened Farmington Canyon road. Enroute, a brief stop will be made to view the Farmington Canyon Experimental Watersheds operated by the Intermountain Forest and Range Experiment Station of the U. S. Forest Service.

The party will return to Hotel Utah about 4:30 p.m.

The trip will be free, except for a 50-cent charge for luncheon. Transportation will be furnished through the courtesy of members of the Utah Section and the U. S. Forest Service.

PINE VIEW DAM, ECHO DAM, AND MOUNTAIN DELL DAM

Buses will leave the Hotel Utah at 10:00 a.m., driving to Ogden, up scenic Ogden Canyon to the Pine View Dam. The Pine View Dam was constructed as part of the Ogden River reclamation project by the U. S. Bureau of Reclamation. It is an earth dam with a concrete cut-off wall and the usual spillway and outlet structures. It is of particular interest because the reservoir now covers the site of the artesian water supply for the city of Ogden. The 43 artesian wells were capped and the water taken out several feet below the ground surface, collected in a common conduit and taken out through the dam and into the new water supply line. A careful check has been made and engineers believe that the flow has been increased because of the weight of the water superimposed in the reservoir. The water in the reservoir impounded by the Pine View Dam is a supplemental supply for lands in Weber and Boxelder counties which were already under irrigation. A part of the water is taken across Ogden Canyon through an inverted syphon supported by a suspension bridge.

Following the visit to the Pine View Dam, the party will return down Ogden Canyon to "The Hermitage" for lunch. This is a delightful rustic summer hotel near the lower end of Ogden Canyon. After luncheon the party will return through Ogden and up Weber Canyon to the Echo Dam on the Weber River. This is an earth dam constructed under the direction of the U. S. Bureau of Reclamation to provide supplemental water for irrigating lands in Weber and Davis counties. Reclamation Service engineers or representatives of the Water Users Association will be at both dams to explain the engineering and other details to the party.

Following inspection of the Echo Dam, the party will go to Parley's Canyon to inspect the Mountain Dell Reservoir, a part of the Salt Lake City water supply system. Mountain Dell Dam is a multiple arch reinforced concrete structure. Engineers from the City Engineer's office will be on hand to describe the construction of the dam and the Salt Lake City water supply system. The party will then return to Salt Lake City, reaching the hotel about 4:30 p.m.

Photo by U. S. Forest Service

CONTOUR TRENCHING FOR FLOOD CONTROL, DAVIS COUNTY WATERSHEDS

Photo Bureau of Reclamation

PINE VIEW DAM, 102 FT HIGH AND 500 FT LONG, NEAR OGDEN, UTAH

Water Conservation Conference

TUESDAY—July 19, 1938

AT HOTEL UTAH, SALT LAKE CITY

Sponsored by the Utah Sectional Committee on Conservation of Water, O. W. Israelsen, Chairman, E. A. Jacob and Frederick W. Cottrell; and Under the Auspices of the Utah Section of the American Society of Civil Engineers

Morning Session

E. A. JACOB, *Presiding*

9:30 **Introductory Remarks by the Chairman**

9:35 **Objectives and Activities of the Society Committee on Water Conservation**

HARRY F. BLANEY, *M. Am. Soc. C.E., Irrigation Engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture*, Los Angeles, Calif.

9:50 **Possibilities of Water Development in Utah**

T. H. HUMPHREYS, *State Engineer*, Salt Lake City, Utah.

10:20 **What Has Resulted from Operation of the Utah Underground Water Law of 1935**

B. F. LOFGREN, *Engineer, State Engineer's Office*, Salt Lake City, Utah.

10:50 **Snow Surveying or Mountain Hydrology as a Factor in Water Conservation**

GEORGE D. CLYDE, *Assoc. M. Am. Soc. C.E., Dean, Engineering and Mechanic Arts, Utah State Agricultural College*, Logan, Utah.

11:20 **Discussion led by**

S. T. HARDING, *M. Am. Soc. C.E., Professor of Irrigation Engineering, University of California*, Berkeley, Calif.

Afternoon Session

HARRY F. BLANEY, *Presiding*

2:00 **Introductory Remarks**

O. W. ISRAELSEN, *M. Am. Soc. C.E., Professor, Irrigation and Drainage Engineering, Utah State Agricultural College*, Logan, Utah; *Chairman, Utah Sectional Committee.*

2:05 **The L.D.S. Church Security Program in Relation to Water Conservation**

DR. JOHN A. WIDTSOE, Salt Lake City, Utah

2:30 **Objectives and Activities of the U. S. Geological Survey Looking Toward Water Conservation in Utah**

A. B. PURTON, *Assoc. M. Am. Soc. C.E., District Engineer, Water Resources Branch, U. S. Geological Survey*, Salt Lake City, Utah.

3:00 **Conservation of Water Through Recharge of Underground Supply**

A. T. MITCHELSON, *Senior Irrigation Engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture*, Berkeley, Calif.

3:30 **Discussion led by**

W. W. MCLAUGHLIN, *Chief of Division of Irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture*, Washington, D.C.

Hotel Accommodations and Announcements

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Annual Convention, paying for the rooms in advance for at least part of the period for which they expect to be in Salt Lake City.

Hotel Rates

HOTEL	WITH BATH	
	Single	Double
Utah	$3.00 up	$4.00 up
Newhouse	2.00 up	3.00 up
Temple Square	2.00 up	3.00 up

The Hotel Utah is the Society headquarters for the Convention. All who attend the Annual Convention are requested to register immediately upon arrival at meeting headquarters. Special badges and tickets will be obtained at the time of registration.

Local Sections Conference

A conference of representatives of the eleven Local Sections in the Western Meeting Region will meet at 9:30 a.m. on Tuesday, July 19, 1938, in the Hotel Utah. The program will schedule topics of professional rather than technical interest, in which all representatives are expected to participate. All members of the Society are welcome to attend.

Student Luncheon and Conference

Student members will meet at luncheon on Tuesday, July 19, 1938, with members of the Board of Direction, Local Section representatives, and others. Following the luncheon it is expected that the student members will meet during the afternoon for discussion of Student Chapter affairs.

Order All Tickets in Advance

Members who order tickets in advance not only will be saved delay by having tickets and badges awaiting them on arrival at headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements.

See Page 22 for Advance Registration Card and Ticket Order.

Information

A registration desk will be provided in the headquarters hotel to assist visiting members in securing desired information about the city. At the registration desk a card file of those in attendance will be maintained, with information as to Salt Lake City addresses.

Entertainment for the Ladies

Attention is directed to the entertainment provided for the ladies on Wednesday and Thursday. It is expected that they will participate with the members in any other features of the program in which they are interested.

Invitation to Student Members

Members of Student Chapters are invited to participate in all the events of the Annual Convention. Particular attention is called to the Student Luncheon and Conference on Tuesday.

The Committee on Arrangements has made arrangements for students attending the Convention to stay at the fraternity houses at the University of Utah in Salt Lake City.

Special Trips or Arrangements

Members desiring to play golf or to take trips to points of individual interest are requested to consult the Registration Desk regarding such arrangements.

Local Committee on Arrangements

K. C. WRIGHT, *General Chairman*
R. A. HART, *President, Utah Section*
F. H. RICHARDSON, *Secretary-Treasurer, Utah Section*
T. C. ADAMS, G. D. CLYDE

Entertainment Committee

R. K. BROWN, *Chairman*
H. C. MEANS, *Vice-Chairman*

FRANK M. ALLEN
ORA BUNDY
SYLVESTER Q. CANNON
J. P. CONGDON
R. F. HAMILTON
MAURICE HOUSECROFT
J. P. MARTIN
C. E. PAINTER
R. S. REINHOLD
R. E. VAN LIEW

Transportation Committee

G. H. TAYLOR, *Chairman*

H. S. CLYDE
E. B. COULSON
H. S. KERR
A. J. LAZENBY
L. F. MACA
J. P. MARSHALL
A. B. MILHOLLIN
L. WENDELBOE
L. M. WINSOR

Publicity Committee

R. A. HART, *Chairman*

A. H. AYERS
H. S. CARTER
F. W. COTTRELL
E. B. FELDMAN
R. W. FIFE
H. C. HUGHES
R. R. MITCHELL
A. Z. RICHARDS
M. T. WILSON

Program Committee

K. C. WRIGHT, *Chairman*

R. K. BROWN
G. D. CLYDE
R. A. HART
O. W. ISRAELSEN
R. B. KETCHUM
O. C. LOCKHART
F. H. RICHARDSON

Finance Committee

J. H. TEMPEST, *Chairman*

E. A. JACOB
H. R. KEPNER
G. D. D. KIRKPATRICK
M. N. MCKENDRICK
J. P. MARSHALL
A. B. PURTON
A. W. SMITH
J. H. YOUNG

Ladies Committee

MRS. HOWARD C. MEANS, *Chairman*

MRS. F. M. ALLEN
MRS. R. K. BROWN
MRS. ORA BUNDY
MRS. S. Q. CANNON
MRS. G. D. CLYDE
MRS. J. P. CONGDON
MRS. R. A. HART
MRS. M. HOUSECROFT
MRS. H. S. KERR
MRS. G. D. D. KIRKPATRICK
MRS. J. P. MARSHALL
MRS. C. E. PAINTER
MRS. R. S. REINHOLD
MRS. G. H. TAYLOR
MRS. K. C. WRIGHT

The program as a whole has been prepared under the direction of the Committee on Regional Meetings, composed of R. C. GOWDY, *Vice-President, Am. Soc. C.E., Chairman;* E. N. NOYES, *Vice-President, Am. Soc. C.E.*, and T. R. AGG, R. A. HILL, T. E. STANTON, JR., and R. K. TIFFANY, *Directors, Am. Soc. C.E.* Please call on the Local Committee on Arrangements or on the Secretary's office for any service desired.

ONE OF THE MANY NATURAL BRIDGES IN SOUTHEASTERN UTAH

SOCIETY AFFAIRS

Official and Semi-Official

District Meeting in Houghton, Mich., in August

MEMBERS of District 7 of the Society, comprising the Dakotas, Minnesota, Wisconsin, Michigan, and adjacent parts of Canada, are planning to hold a summer gathering at Houghton, Mich. The dates set are August 25–27. Business and pleasure will be combined to best advantage.

The meeting is scheduled to start with a golf tournament and barbecue on the first day, Thursday, August 25. With this introduction, it is felt that those attending will be in the proper frame of mind to settle down to more serious matters on the following day, Friday, which will be entirely devoted to non-technical papers and discussions of Society problems, rounded off by a banquet in the evening. Then, on Saturday, the U. S. Engineer Office will be host at a special inspection trip to the extensive work now in progress on the Keewenaw Channel in Lake Superior.

Members in District 7 are enthusiastic over the Houghton meeting and will support it generously. But all other Society members who can arrange to be present are cordially invited. Some of the Society officials, including President Riggs and Vice-President Gowdy, have already made plans to include this event. Others, whatever their connection with the Society, are more than welcome.

It is thought that many members, knowing of this attractive meeting, will want to plan their vacation so as to include it. The northern peninsula of Michigan is noted for its scenic beauty and vacation attractions. Any members who find it possible to be in this vicinity will be well repaid if they plan definitely to spend this weekend, together with their families, in Houghton, Mich., to enjoy the program.

In order to assure satisfactory accommodations, members residing outside District 7 who plan to attend, should notify Grover C. Dillman, president of Michigan College of Mining and Technology, Houghton, Mich., chairman of arrangements.

Midwest Student Chapters Organize

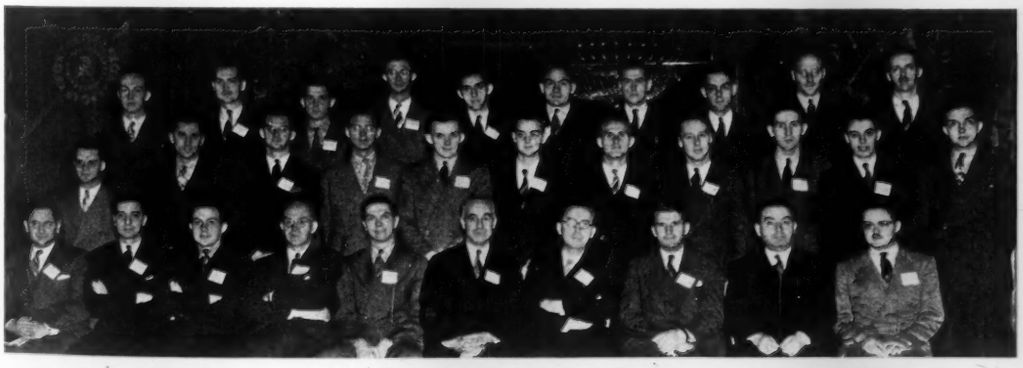
UNDER the auspices of the Illinois Section and the Student Chapter at Lewis Institute, a group of 50 students, and faculty from seven Student Chapters in midwestern engineering colleges, met in Chicago for a two-day assembly and inspection trip on Friday and Saturday, May 20 and 21. Early on Friday the delegates met at the University of Iowa. The chapters present were from the Universities of Illinois, Marquette, Iowa, and Minnesota, and from Iowa State College, Rose Polytechnic, and Lewis institutes. They organized, elected officers, and determined to meet again in 1939 in Chicago, at a convenient date to be fixed by a committee composed of a member of the Board of Directors of the Illinois Section, two Juniors of that Section, and a Faculty Adviser. It is hoped to expand the feature of the inspection of engineering works at next year's gathering and to select a time that will permit the attendance of many other Chapters.

After addresses by President Riggs, Past-President A. J. Hammond, and Secretary George T. Seabury, the group were guests of the Illinois Section at the Chicago Engineers' Club. President Riggs addressed the members of the Section and its guests on the changes that are taking place in the Society, and the various advantages that accrue to those who take an active part in its work. Professor J. G. Bennett, president of the Illinois Section, introduced professors from the various colleges, who presented their candidates. President Riggs then presented the annual awards of the Section to an outstanding senior civil engineering student from Armour, Lewis, and Rose Polytechnic institutes, and from Illinois, Purdue, and Northwestern universities. These awards, each of which consists of a certificate, one year's dues as a Junior in the Society, and a Junior badge, were made to the following students:

Armour Institute of Technology	William F. Schlax
University of Illinois	Harold E. Goeke
Lewis Institute	Nando J. Petterino
Northwestern University	Randolph N. Jacobson
Purdue University	Frank T. Sheets
Rose Polytechnic Institute	John E. Lindeman

In the afternoon the students took an inspection trip to the old Chicago Avenue pumping plant and to the Hyde Park lake intake crib of Chicago's water supply system, in the course of a cruise along Chicago's famous lake front. Improvement works at the mouth of the Chicago River were also visited. Lewis Institute entertained the conference at the Medinah Club in the evening.

The Saturday morning session, which was presided over by Prof. Frank Kerekes, M. Am. Soc. C.E., of Iowa State College, was devoted to reports from each Chapter present and to addresses by prominent members of the profession. B. F. Affleck, former president of the Universal Atlas Portland Cement Company, pointed out that an important element in the achievement of success is the cultivation of the ability to make friends, to make people like you. A comprehensive view of the opportunities open to young engineers in the field of traffic control and management was given by Otto K. Jelinek, traffic engineer of the Chicago Park District. At luncheon, L. D. Gayton, M. Am. Soc. C.E., city engineer of Chicago, in an address gave "Advice to the Young Civil Engineer."



MIDWEST STUDENT CONFERENCE, CHICAGO, MAY 21, 1938

On Saturday afternoon those attending the conference were free to participate in one or another of a wide choice of prearranged inspection trips, ranging from purely technical and educational to personal entertainment—from the art of sewage treatment and disposal, and the boring of water supply tunnels, to museums and the White Sox–Yankee baseball game.

It is planned to continue the conference as an annual event of the Student Chapters in the Midwest.

in the Medinah Club, with Leonard M. Gordon, president of the Institute Chapter presiding. The welcoming addresses of Dean Rogers of the Institute, J. L. McConnell, Contact Member of the Chapter at the Institute, and E. W. DeBerard, president of the Chicago Juniors of the Illinois Section, were acknowledged by E. L. Waterman, M. Am. Soc. C.E., Professor of Sanitary Engineering

Jacksonville Meeting Well Publicized

A MEETING of the Society has all the elements of a lot of good stories for the newspapers—but it requires no small amount of effort "to put those stories across." With this in mind, the committee in charge of the Spring Meeting in Jacksonville saw to it that a local engineer was appointed, considerably in advance of the meeting, to take charge of all news releases.

The man selected was Martin Fabian, an engineer in the office of the City Engineer of Jacksonville. Mr. Fabian had never handled this type of work before, although his versatility had been demonstrated through the direction of local radio programs, a considerable expertness in sound effects for radio, and participation in local theatricals. He was singled out for the publicity assignment by the local committee early in April, and his first news story appeared in a Jacksonville paper on April 4. This was followed by one or two articles almost every day until the week of the meeting, when a flood of excellent publicity material was printed. Through Saturday, April 23, when the meeting ended, he had supplied or stimulated a total of 1,604 column inches in local papers, including pictures. Part of this material related to the Florida Engineering Society and part to the American Shore and Beach Preservation Association, which were meeting in Jacksonville at the same time.

The organization of the work may be of interest. The manager of the George Washington Hotel, at which the meeting was held, generously assigned a convenient room as publicity headquarters, where a certain amount of office equipment was set up. Here the publicity director spent about half his waking hours during the first three weeks in April, preparing and distributing his stories. The Society's Manual for Publicity was helpful in opening up new channels of interest, and a copy of the Year Book was practically worn out.

As the meeting week drew near, the work became more highly organized. More typewriters were installed, a number of assistants were put to work (most of them volunteers), and by Tuesday of meeting week there were at times a dozen people, including newspaper men, absorbed in the exacting work of publicity headquarters. Needless to say, Mr. Fabian was on leave from his office all that week, and devoted every ounce of energy, day and night, to the publicity job.

The editors of Jacksonville newspapers as well as the representatives of national press services, showed their appreciation by keeping reporters and press photographers on the job and accepting practically every story that was released. A clipping service, to which the Society subscribes, afterwards turned in 172 clippings about the Society meeting from 76 newspapers in 40 cities in 13 states, for a total of 1,650 column inches. This of course represented a national rather than a local coverage and excluded the meetings of the two other societies included in Mr. Fabian's total on April 23. It is safe to say, however, that all of it resulted from the publicity work at Jacksonville.

It was perhaps fully as much because of the cordial relationships established and maintained by the publicity director with the editors, reporters, and news agencies, as it was because of the excellent quality of the stories themselves that the publicity for the Spring Meeting of the Society at Jacksonville can be classified as an extraordinarily fine job. The Society owes a debt of appreciation to Mr. Fabian, to his volunteer assistants, and to all who cooperated in the work.

New England Student Chapters Hold First Conference

THE Conference of New England Student Chapters of the Society was organized at Rhode Island State College on May 6, 1938, when representatives of the Chapters at New Hampshire University, Worcester Polytechnic Institute, Brown University, and Rhode Island State College, together with Faculty Advisers, Contact Members, officers and members of the Society, conducted its first meeting.

Dean Royal L. Wales welcomed the group to Rhode Island State College, and Prof. A. H. Holt, member of the Society's Committee on Student Chapters, discussed Chapter affairs. Charles B. Solomon of the Rhode Island State Chapter read an original paper on "Problems of Sewage Disposal," which had been the winner of first prize in a contest conducted by the Providence Section earlier in the year.

A constitution for the conference was adopted, officers and delegates were elected, and it was decided to hold the meeting next year at New Hampshire University. All the Student Chapters in New England are eligible to membership in the new conference.

Following dinner that evening, Prof. Hardy Cross of Yale University spoke on "This Profession of Ours."

Credit for the organization of this ninth regional group is due to the officers and members of the Student Chapter at Rhode Island State College, of which Arthur F. DeCesare was president, and Edgar F. Sanborn, Jr., was secretary.

Unusual Use of Society Records

THE Society has opportunity to perform many services both to members and to others associated with the engineering profession. Recently, in connection with personnel information being gathered by a few major employers of engineers, it apparently became necessary for the engineering staffs to furnish documentary proof of date of birth. In the instances to which reference is made, birth certificates were not available and requests were made to Headquarters to furnish photostat copies of the original applications for membership. An affidavit was prepared by the Society to accompany each of these photostat records, certifying that the reproduction is a true and accurate copy of a manuscript extracted from Society files. It will be of interest to note that the Society has on file the original membership applications, bearing the applicant's signature, dating back as far as 1872.

New Sections Have Their First Meetings

THE TWO recently established Sections of the Society—the Mohawk-Hudson and the Wyoming Sections—have initiated their activities with interesting meetings. On May 23 the members of the Mohawk-Hudson Section met at the University Club in Albany. Preceding the meeting, 30 members attended a dinner in honor of Henry E. Riggs, President of the Society, and George T. Seabury, Secretary.

After dinner Arthur W. Harrington, Director from District 3, gave a report on the Spring Meeting of the Society. He was followed by Mr. Seabury who spoke briefly, outlining the activities of the Society in behalf of the profession and pointing out the fact that the Society can best serve the economic needs of the membership through the medium of the Local Sections. Warren C. Taylor, who has been elected president of the Section, then introduced Dr. Riggs. In his talk Dr. Riggs discussed the three or four fundamental changes in the development of the Society that have affected its organization.

In addition to Professor Taylor, the officers of the Mohawk-Hudson Section are Edward W. Wendell, vice-president; Paul R. Speer, secretary; and G. Reed Shaw, treasurer.

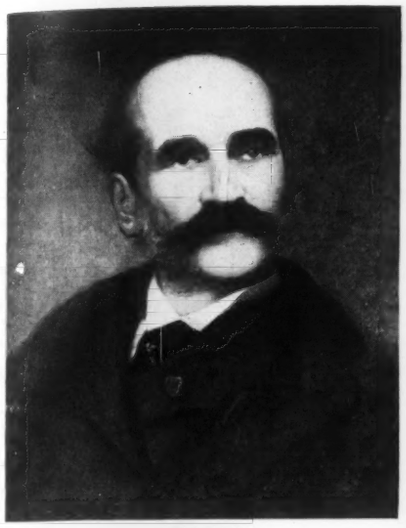
The first meeting of the Wyoming Section was held jointly with a session of the Colorado Section at Fort Collins, Colo., on the afternoon and evening of June 11. The program began with an inspection of the hydraulic laboratory, where models of dams and spillways were being tested, and of the recently completed municipal steam-electric power station. A specially arranged program of motion pictures was then shown to fill in the time before dinner, which was held in the college cafeteria on the campus of Colorado State College.

Following dinner Ralph L. Parshall, chairman of the arrangements committee, introduced R. L. Downing, president of the Colorado Section, and the visiting engineers from Wyoming and Nebraska. Mr. Parshall then gave a brief history of the laboratory, of which he has been director for many years, describing its joint operation by the U. S. Department of Agriculture, the U. S. Bureau of Reclamation, and the Colorado Agriculture Experiment Station. The concluding speaker was R. C. Gowdy, Vice-President of the Society, who made some announcements concerning the forthcoming Annual Convention of the Society. The officers of the Wyoming Section are Ralph D. Goodrich, president; Wilbur H. Fisher, vice-president; and Alex J. McGaw, secretary-treasurer.

Early Presidents of the Society

XXVIII. ALPHONSE FTELEY, 1837–1903
President of the Society, 1898

UNLESS he has the rare good fortune to be commemorated in the naming of a bridge, like Eads or Goethals, or of an airport, like Chanute, it seems to be the fate of an engineer to be remembered—if at all—as a mathematical equation. He may even, like Poisson, be reduced to the status of a dimensionless number.



ALPHONSE FTELEY
Twenty-Eighth President of the Society

The transubstantiation usually requires less than a generation. Thus, except to his surviving friends, the name of Alphonse Fteley already suggests little more than a weir formula—and even that remembrance is shared with his assistant in research. Certainly the contribution of Fteley to experimental hydraulics is not to be belittled. But it constituted only a small part of his accomplishments and was incidental to his main work—the design and construction of water-supply systems.

Alphonse Fteley was born in Paris, France, on April 10, 1837, and was educated and began his professional career in that country. He came to the United States at about the close of the Civil War, and entered the office of William E. Worthen, Past-President Am. Soc. C.E., as his general assistant.

After four years with Worthen, and three years in private practice, he was engaged by the Boston Water Board to be resident engineer in charge of the construction of the Sudbury River water-works system for the city of Boston. This work, costing about $5,000,000, was at that time considered as among those of first importance in this country. Its purpose was to supplement the Cochituate supply, which had become inadequate within ten years of its completion.

The Sudbury project comprised (initially) three storage reservoirs, a collecting pond, and a 15.9-mile aqueduct crossing two valleys on stone arch bridges. The conduit went into operation in 1878, and the reservoirs were in full service two years later.

In connection with this work, Fteley carried out a series of observations for gaging the flow of the Sudbury River. His study, published in *Transactions* in 1881, was described by J. James R. Croes as the most accurate and long-continued observation of the kind that had been made in the United States up to that time. (The period covered was five years—1875 through 1879.) The recording gage used by Fteley to obtain a continuous record of water-surface elevation is shown in Fig. 1.

This research led directly to the famous weir experiments conducted by Fteley with the assistance of F. P. Stearns, M. Am. Soc. C.E. The paper describing them appeared in *Transactions* in 1883, and was awarded the Norman medal. In point of time, Fteley's experiments lie between those of Francis (1852) and those of Bazin (1888). The Fteley formula is based on his own work and that of Francis as well, and takes into account more accurately than the Francis formula the velocity of approach. Bazin in turn made use of Fteley's data.

The Sudbury project is fully described in "Boston Water Works: Additional Supply from the Sudbury River"—a book by Fteley published in 1882. Of special interest therein, as reflecting the state of the art at that time, is the description of the dams:

"In the valleys where the three dams were to be located, clay is never found, but there exist extensive strata of gravel and sand, from the coarsest gravel to the finest quicksand. No definite plan could be decided upon for the foundations of the dams until a full knowledge of the underground formation was obtained.

"The borings were made with 5-in. cast-iron pipes, which were driven to various depths, extending in several cases to more than 60 ft. In order to have a correct idea of the perviousness of the ground, the water-bearing capacity of the strata was frequently tested by pumping from the pipe. In each case the samples obtained by boring were disposed in large glass tubes on a scale of one inch to one foot of depth. These tubes, arranged according to the position of the corresponding soundings in the valley, furnished, better than any drawing, the indications needed for locating and designing the foundations.

"The general mode of construction is the same for the three dams. The material being of a pervious nature it was not thought sufficiently safe to erect the main body of the dam on comparatively shallow foundations, and to attempt to secure the imperviousness of the dam by means of embankments formed of the materials found on the ground. It was judged necessary to build in the middle of the embankments an impervious wall, and to produce it, as well as the foundations of the overflows and of the gate-houses to such a depth as to prevent any injurious action of the water. Clay not being found in the neighborhood it was decided to resort, for the center walls, to the use of stone masonry laid in cement mortar.

"The earth banks on the upstream side of the center walls were formed with the best materials (often mixed together) to be found on or near the grounds, laid in thin layers, wetted, and well compacted. It being expected that some percolation would take place through the banks and the center walls, all the banks on the down-stream side were formed of gravel."

Dam No. 2 is shown in an accompanying illustration. Like the others, it consisted of three parts: a waste overfall made of rubble masonry laid in mortar, with the toe protected by sheet piling; a gate chamber of cut granite on a rubble-stone foundation; and the embankment section, already described. The fill is about 24 ft above the original ground surface, and the cutoff extends about the same distance below it.

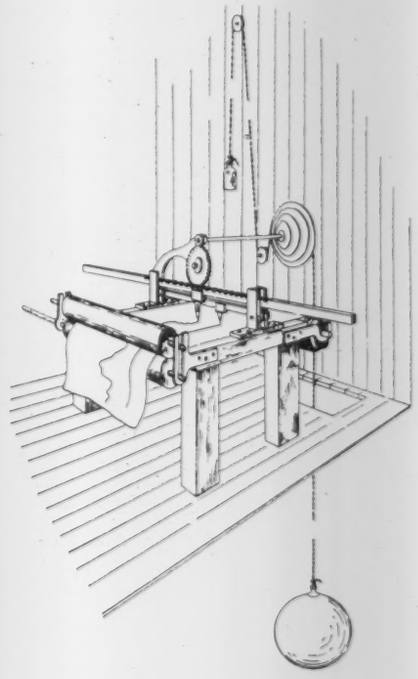


FIG. 1. RECORDING GAGE USED BY FTELEY ON SUDBURY RIVER, 1876

In 1880 Fteley was appointed assistant city engineer of Boston, and was engaged in designing many structures, especially for the water-works and the main drainage and park systems of the city, until 1884. In that year he left Boston to accept, from the Aqueduct Commission of New York City, the position of principal assistant engineer on the new Croton Aqueduct, under Benjamin S. Church, the chief engineer. In 1886 his title was changed to consulting engineer, and in 1888 he replaced Church as chief engineer.

As principal assistant engineer he had charge of the design of the aqueduct, of a dam for the Quaker Bridge site, and of other important dams, structures and reservoirs and also of the preparation of the specifications and contracts for their construction. After his appointment as chief engineer, investigations were renewed for the location and design of the proposed dam to complete the storage of the Croton watershed, and it was decided to build the New Croton

Dam at a point some distance upstream from the Quaker Bridge site. Fteley continued his connection with this work until 1899, when he was compelled by ill health to resign and retire from the active practice of his profession. With the exception of the New Croton Dam and the Jerome Park Reservoir, all the important features of the Croton water supply were completed before his retirement.

During his most active years, Fteley was engaged as consultant on many important works and studies, among them those under the charge of the Metropolitan Water Board of Massachusetts; the Sewerage Commission of New Jersey; the Rapid Transit Commission of New York City; the Boston Rapid Transit Commission of 1892; the Cataract Construction Company of Niagara Falls, N.Y.; the Schuylkill Navigation Company; and the Board of Works of Newark, N.J. He was also consulted on the Aqueduct Tunnel repairs of Washington, D.C.; the additional water supply of Rochester, N.Y.; the supply of water to New York City from New Jersey; the additional water supply for Cincinnati, Ohio; and the additional supply for Brooklyn, N.Y.

An obscure heart trouble from which he suffered during the last thirty years of his life limited Fteley's capacity for work at times, although it seemed to have little effect on results. In 1894 his general health began to fail, still further limiting his physical activity—but that this in no wise impaired his courage and ability to direct is evident by the progress of the work of the Aqueduct Commissioners after that date and up to the time of his retirement as chief engineer. He died on June 11, 1903, at his home in Yonkers, N.Y., survived by a daughter and four step-children.

Fteley was elected a member of the Society in 1876, and was active in its management for a number of years, serving as Director in 1888 and as Vice-President in 1889, 1890, and 1891. In 1898 he was elected President and, from the expiration of his term to the time of his death, continued to take great interest in its affairs.

He was a man of great personal charm, and his ability to win the enthusiastic loyalty of his subordinates was one of the things that made it possible for him to accomplish a great deal during the years when his health would not permit of much physical activity. "The best that there was in a man," said the writers of his memoir, "was always at his command. The confidence inspired by his high character, and his kindliness and manifest broad sympathies, caused his subordinates to feel that in him they could always find a friend as well as a respected and acknowledged leader."

"DAM NO. 2" OF THE SUDBURY RIVER WATER-WORKS SYSTEM; COMPLETED 1877

And thus ends the story of a man who became an equation.

A Busy President

ONCE every 2.8 days since he assumed office, President Riggs has visited a Local Section or Student Chapter, or attended a meeting of some other engineering group as the official or unofficial representative of the Society. His travels have carried him first to New England, thence to the Hawaiian Islands, back across the southern tier of states from the Pacific to the Atlantic, and finally to various points in the Middle West and along the east coast. The accompanying map is complete to June 3, when the forty-eighth visit was made.

The value to the Society of this contribution of time and energy can scarcely be overestimated. It is by such visits that the Local Sections are brought into closer contact with the national organization, and that the Student Chapters are given a broader and clearer picture of the society of which they also are a part.

President Riggs' visits in January included the Northeastern, Providence, and District of Columbia Sections. In February he was in Hawaii, visiting the newly formed Local Section at Honolulu and attending meetings of the Engineering Association of Hawaii, the Hawaii Society of Engineers, and the Engineering Associates of Hawaii. He also addressed the students at the University of Hawaii.

The March itinerary included: University of California Student Chapter; San Francisco Section; Stanford University Student Chapter; Sacramento and Los Angeles Sections; California Institute of Technology Student Chapter; San Diego Section; University of Southern California Student Chapter; Arizona Section; University of Arizona Student Chapter; the Arizona Roads and Streets Conference; joint meeting of Student Chapter of University of New Mexico and New Mexico Section; the Kiwanis Club and Texas Technology College Student Chapter at Lubbock, Tex.; the Texas Section and students at Southern Methodist University at Dallas; Texas Agricultural and Mechanical College Student Chapter; Engineering Society of Huston; Rice Institute Student Chapter; a group of members at Austin; and the Texas Section at San Antonio.

In April he addressed a group of members at Harlingten, Tex.; attended a conference on higher education and a dedication of new buildings and visited the Student Chapter at Louisiana State University; and visited the Louisiana Section, the University of Alabama Student Chapter, the Alabama and Georgia Sections, and the conference of New York State Sections and Northern New York Conference of Student Chapters. He also presided at the Society's Spring Meeting in Jacksonville, Fla.

In May there were visits with the senior engineering students at the University of Michigan; with the Illinois Section; the North Central Student Chapter Conference; and Union College Student Chapter. He also attended the organization meeting of the Mohawk-Hudson Section; a meeting of the Albany-Schenectady group of University of Michigan alumni; the Rensselaer Polytechnic Institute faculty; the Junior Branch of the New York Metropolitan Section; the Connecticut Section; and a joint meeting of the Maryland Section and the Johns Hopkins and University of Maryland Student Chapters.

The last stopping point shown on the map is the Toledo Section, which was visited on June 3.

VISITS OF PRESIDENT RIGGS, JANUARY 24 TO JUNE 3, 1938

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

Meeting of A.E.C. Executive Committee

THE SPRING meeting of the Executive Committee of American Engineering Council was held in Philadelphia on May 13. The committee discussed and acted upon a number of public questions and projects. It was voted to record by resolution the approval of the appointment of a special congressional committee to conduct a fact-finding investigation of the TVA. This resolution appears in the Bulletin.

It was voted to empower the President of Council to appoint a special committee representing the profession as a whole to cooperate with the staff of the Army and Navy on questions of national defense. This proposal was in accordance with the recommendation voted by the Assembly at the January meeting.

Favorable consideration was given to a proposal to sponsor a special inquiry into the status of young engineers under the general direction of the A.E.C. Engineering and Allied Technical Societies Committee on Engineers Economic Status, of which Prof. J. S. Dodds is chairman, the work to be conducted by the Personnel Research Federation with funds supplied by the Engineering Foundation.

A factual study of the relation of patents to monopoly, proposed by Chairman R. S. McBride of the A.E.C. Patents Committee was approved, provided the budget for the purpose could be obtained from sources outside of our present member organizations.

The Executive Secretary announced the election of the Engineers Club of Memphis and the Structural Engineers Association of California as members of American Engineering Council, bringing the total members of Council up to 52, the largest in its history.

The Executive Committee received many expressions of approval of the proposed series of public forums to be conducted by American Engineering Council. Consideration was given to several suggestions for extending and developing the forum idea, and plans were discussed for finding ways and means of putting the results of the series of forums in printed form. The Public Affairs Committee, under whose auspices the forums are being directed, will be particularly glad to receive suggestions and subjects for future forums.

Public Works Administration

As the Public Works Administration clears its decks for the new 1938 program, authorized by Congress, the "how, where, when, and why" of that program become major items of interest to architects, contractors, engineers, and all of those engaged in business and industry from which must come equipment, materials, and supplies for a public works construction campaign which may eventually involve as much as $1,866,000,000. All of that would be an addition to what is yet to be done to wind up construction of projects with an estimated total cost of approximately $1,000,000,000.

How.—The 1938 Act authorizes a fund of $965,000,000 for allotments for "useful public works projects" of the kind and type heretofore carried forward by PWA. Up to $750,000,000 of this amount may be used for grants for non-federal projects. Grants will not exceed 45 per cent of the cost of the project. Up to $200,000,000 of the fund may be used for federal projects to be selected from certain designated classes. The fund thus set up will make it possible to authorize projects having total construction costs of $1,866,000,000; because the provision of $750,000,000 in grants would demand local contributions of $896,000,000 exclusive of the $200,000,000 for federal projects. These figures include the use of the $400,000,000 revolving fund for financing loans for non-federal projects.

Full financing must be provided for in plans for any project. The Act provides that no federal funds are to be advanced to any public agency unless adequate provision has been made for financing the part of the project cost not supplied from federal funds. All contracts for loans and grants will contain appropriate provisions to assure certain labor preferences "in so far as practical and feasible." Exclusive of executive, supervisory, administrative, and non-manual employees, preference shall be given to bona fide residents of the state, territory or possession in which the project is located, who have resided therein for at least 90 days. The order of that preference shall be (1) veterans, (2) citizens of the United States, (3) aliens whose valid declarations were filed prior to the date of enactment of this statute, and (4) other legally entered aliens. Over-all preference shall be extended persons from the public relief rolls. All labor must be chosen from lists of qualified workers submitted by the local office of the U. S. Employment Service.

Where.—Projects can be carried out in every part of the United States. Non-federal projects can be undertaken by "states, territories, possessions, political subdivisions or other public bodies." Federal projects of certain classes can be constructed in the United States "including the territories and possessions of Alaska, Puerto Rico and Hawaii." Localities wishing projects may file applications with any one of seven PWA regional offices located in Atlanta, Chicago, Fort Worth, New York, Omaha, Portland, Oregon, and San Francisco. A subregional office is located at Harrisburg, Pa. Applications will be examined in the regional offices and recommendations will be made to Washington as to action. Final approval will be given in Washington.

The only PWA project applications on which PWA can act are the official applications of public bodies authorized by local law and federal statute to undertake qualified and justified public improvements. Authorized local public bodies can use their own judgment about whom they may consult, but PWA's action must be based upon procedure fixed by law. It is futile and wasteful for applicant bodies to seek to submit pleas through unusual channels or incur expense in the hope of securing favored treatment. In other words, sponsors are warned by PWA that it is unnecessary to employ lobbyists on any basis.

When.—The program will go into action immediately. At the direction of President Roosevelt, PWA is preparing for allotment immediately after the signing of the bill, a list of projects with total construction costs of $600,000,000. That is being done from the 2,714 pending projects, already chosen by hundreds of communities; and approved by PWA's legal, finance and engineering divisions.

New applications for non-federal projects must be filed with PWA by midnight September 30, 1938, to be eligible for consideration under the provisions of the bill. This deadline does not apply to amendatory applications filed or applications which were submitted prior to October 1, 1937. Projects must be started prior to March 31, 1939, and substantially completed by September 30, 1940. This does not apply to any project enjoined in any state or federal court.

The Public Works Administration itself is continued to July 1, 1941. It is, therefore, implied by this Act of Congress that other appropriations may be made between now and 1941 for public works construction purposes. Engineers planning public works programs for communities may find it advantageous to have applications approved in advance and in readiness for immediate use.

Why.—The Act specifies that the new program is to be undertaken "in order to increase employment by providing for useful public works projects of the kind and character which the Federal Emergency Administrator of Public Works has hitherto financed or aided in financing." Skilled and non-skilled labor from relief rolls is to have preference wherever it is suited to the work which a project makes available. Veterans come next and then qualified unemployed citizens, etc. It is believed, however, that 2½ man hours of work is provided in industry for every man hour on the site. Labor behind the lines is not subject to restriction.

Washington, D.C.
June 11, 1938

Review of Engineering Education to Be Published by E.C.P.D.

SUPPORTED by a grant of $10,000 from the Carnegie Foundation for the Advancement of Teaching, the Engineers Council for Professional Development has arranged for the preparation and publication of a "Report on Engineering Education in 1937." This will be based on the great amount of information which has been gathered by the E.C.P.D. Committee on Engineering

Schools in connection with its investigation for purposes of accrediting of all the engineering curricula in the degree-granting institutions of the United States. The work will be in charge of Dr. Dugald C. Jackson, emeritus professor of electrical engineering at the Massachusetts Institute of Technology, and formerly president of the Society for the Promotion of Engineering Education.

It is expected that the report will be ready for publication within a year, and copies will be distributed to important engineering libraries and officials of the engineering schools and engineering societies.

Leaflet on Fees Reprinted

THE REPORT on fees for professional engineering services, first published by the Society in 1935, has been reprinted. In the new edition it consists of four 8½ by 11-in. sheets, printed on one side only, which makes it suitable for inclusion in contract documents. Copies can be obtained from Headquarters at 10 cents each.

The full title of the report is "Recommendations for Determining Fees for Professional Engineering Services on Federal and Federal Aid Projects Undertaken as an Aid to Industrial Recovery or to Relieve Unemployment." It was prepared by the Society's Committee on Fees when that group consisted of E. R. Needles (chairman), W. W. Colpitts, J. V. Davies, J. F. Sanborn, and D. B. Steinman. It should not be confused with Manual No. 5, "Charges and Methods of Making Charges for Professional Services."

The present committee, with whose recommendation the recent reprinting has been effected, consists of Frank A. Marston, chairman; J. V. Davies, Walter L. Huber, Ernest E. Howard, and E. R. Needles.

In and About the Society

A POSTCARD bearing the following request was recently received by the Engineers' Council for Professional Development: "Sir: Will you kindly send me the price of the following book? 'Engineering, A Beauty, A Culture.' Thank you." E.C.P.D. was forced to admit it had done nothing along that line—but it might be well to point out that its pamphlet on "Engineering: A Career—A Culture" has already had a distribution of some 45,000 copies, and more are available at the price of 10 cents each, at the Council's headquarters, 29 West 39th Street, New York, N.Y.

* * * *

ANOTHER "pin that came back" story has been called to our attention. Fred E. Foss, M. Am. Soc. C.E., telephoned Headquarters recently to say that the Society pin he lost ten years ago had just been found. The odd part of the story was that the badge turned up, not in a bureau drawer or at the bottom of the basement coal pile, but on a busy street corner in New York City.

Who else has a badge with a history?

Appointments of Society Representatives

RALPH BUDD, M. Am. Soc. C.E., has been reappointed to represent the Society on the Hoover Medal Board of Award for a six-year term expiring May 1944.

CHARLES B. BURDICK, M. Am. Soc. C.E., has been appointed one of the Society's representatives on the Washington Award Commission for a two-year period.

LEON S. MOISSEIFF, M. Am. Soc. C.E., has accepted an appointment to represent the Society at the Semicentennial Celebration of the Founding of the American Mathematical Society, to be held at Columbia University, New York City, September 6–9, 1938.

GEORGE A. ORROK, M. Am. Soc. C.E., and W. J. BUCHANAN, Assoc. M. Am. Soc. C.E., acted as Society delegates to the International Engineering Congress held in Glasgow, Scotland, June 21–24, 1938.

J. P. H. PERRY, M. Am. Soc. C.E., has been reappointed one of the Society's representatives on United Engineering Trustees, Inc., for a three-year term.

News of Local Sections

Scheduled Meetings

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

SAN FRANCISCO SECTION—Outing of the Junior Forum at Woodside on July 17, at 11 a.m.

SPOKANE SECTION—Luncheon meeting at the Crescent Tea Room on July 8, at 12 m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on July 4, at 12:15 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on July 9, at 12 m.

Recent Activities

ARIZONA SECTION

About 100 attended the annual spring meeting of the Arizona Section and the University of Arizona Student Chapter. This affair, which was held in Tucson on April 30, included a luncheon with the Tucson Chapter of the American Association of Engineers and a dinner with the Student Chapter. Edward Young, president of the Student Chapter, acted as toastmaster at the dinner meeting, at which this year's Section prize for outstanding scholastic achievement was awarded to George L. Haynes. The list of technical speakers heard during the day included Vic. H. Housholder, second vice-president of the Arizona Section; L. J. Foster, construction engineer for the U. S. Bureau of Reclamation; K. H. Talbot, concrete engineer for the U. S. Bureau of Reclamation; John A. Carollo, consulting engineer of Phoenix; and Tom R. Johnson, associate engineer for the U. S. Bureau of Reclamation. Ten-minute talks were also given by George L. Haynes, Jr., Sam Tucker, and Kenneth W. Hammes, senior civil engineering students.

BUFFALO SECTION

On April 11 the Buffalo Section cooperated with the Engineering Foundation of Buffalo and other technical societies in sponsoring a talk by Capt. John D. Craig, explorer and deep sea diver, who gave an illustrated lecture on deep sea diving. There were 31 present at a luncheon meeting of the Section, which took place on April 19. Following luncheon and a business discussion, William P. Creager was introduced. Mr. Creager, who is a consulting engineer and member of the executive committee of the Soil Mechanics and Foundations Division of the Society, discussed the methods and benefits of flood control. On May 10 about 50 members of the Section enjoyed an inspection trip to the Niagara Falls sewage disposal plant in the Niagara River gorge. This was followed by a dinner meeting in the Niagara Hotel. After a few remarks by Edward P. Lupfer, former Vice-President of the Society, Arthur W. Harrington, Director of the Society and district engineer (at Albany, N.Y.) for the U. S. Geological Survey, spoke. Mr. Harrington's topic was the work of the water resources branch of the Survey, which he supplemented with lantern slides.

CENTRAL OHIO SECTION

A joint meeting of the Central Ohio Section and the Ohio State University Student Chapter took place on May 18, with 64 present. The program had been arranged primarily for the education of the students in Society matters, so the speakers were J. E. Root, Director of the Society, and George T. Seabury, Secretary. The subject of Mr. Seabury's talk was "What an Engineering Organization Means in the Life of an Engineer."

CLEVELAND SECTION

The Cleveland Section of the Society and the Student Chapters at Akron University and Ohio Northern University were guests of the Case School of Applied Science Student Chapter on May 3. After a brief talk by Dr. W. E. Wickenden, president of the Case School, the deans of the three engineering schools represented presented the Cleveland Section prizes of membership in the Society to the outstanding graduates of their respective schools.

The Juniors then gave brief résumés of their work on their theses, and at the conclusion of the meeting the group visited the civil engineering laboratories to see these projects, and the dam models for the Ohio River flood control project in operation in the hydraulic laboratory.

COLORADO SECTION

There were 20 present at a meeting of the Junior Association of the Colorado Section, which took place on April 25. After a business session J. E. King, who is in charge of surveys and maps for the Rocky Mountain region of the U. S. Forest Service, spoke on aerial surveys. After his talk Mr. King showed the equipment and some of the operations connected with making maps from aerial surveys.

DAYTON SECTION

The program at the April luncheon meeting of the Dayton Section consisted of the showing of a sound motion picture entitled "The Romance of Iron and Steel." This was presented through the courtesy of the Ohio Corrugated Culvert Company. The attendance numbered 21. The May meeting took the form of an inspection trip to the recently completed research laboratory of the American Rolling Mills Company at Middletown, Ohio, which is unusually modern and complete. There were 16 present on the trip and at the dinner which preceded it.

DISTRICT OF COLUMBIA SECTION

Members of the Junior Forum of the District of Columbia Section held their first meeting on April 25. W. S. Eisenlohr, Jr., read the draft of the present constitution of the Junior Forum and outlined the activities of the Forum since its inception two years ago. Plans for future meetings were then discussed, and officers were elected for the coming year. These are W. S. Eisenlohr, Jr., president; Richard L. Woodward, vice-president; and T. Ritchie Edmonston, secretary-treasurer. The technical program consisted of the presentation of a two-reel motion picture showing the construction of the Mount Vernon Memorial Highway. At the meeting held on May 23, Frank Cardile and Milton Dubin, who have been making tests at the U. S. Bureau of Standards on the materials used in low-cost housing projects, spoke. Mr. Dubin explained the type of tests used by the Bureau of Standards on various building units, while Mr. Cardile showed slides illustrating the different types of modern prefabricated houses being constructed at the present time. Various business matters were also discussed at this session, which was well attended.

DULUTH SECTION

A luncheon meeting of the Duluth Section, which took place on April 18, was largely given over to business discussion. During this session R. M. Palmer, vice-president of the Section, was elected president in place of A. B. Jones, who has moved to another city. W. H. Woodbury was moved from the office of second vice-president to that of first vice-president, while Frank Hutchinson was made second vice-president. At the conclusion of the meeting the subject of unionization of engineers in the state was discussed. The feature of the May 16th meeting was a talk by N. T. Rykken, of the Portland Cement Association, who discussed the advances recently made in the manufacture of concrete.

ILLINOIS SECTION

The Juniors of the Illinois Section report the close of an interesting and successful year. On April 25, P. D. Beaner, of the Johns-Manville Corporation, gave an illustrated lecture on heat and its control. At the last regular meeting, which was held on May 23, M. W. Loving, of the American Concrete Pipe Association, spoke on the design and use of large concrete pipe. The closing of the active season for the group was marked by a smoker held at the Chicago Engineers Club on June 3.

On May 20 and 21 the Illinois Section and the Student Chapter at Lewis Institute held a two-day assembly and inspection trip, which is reported elsewhere in this issue.

INDIANA SECTION

On May 10 the Indiana Section and Purdue University Student Chapter held a joint dinner meeting at the university, the high point of the evening being the presentation of student prizes to Henry F. Hill and Joseph L. Waling. Frank T. Sheets, president of the Portland Cement Association, was the principal speaker of the evening and discussed the subject, "The Value of Research to the Practicing Engineer." Joseph E. Root, Director of the Society, also addressed the group. The list of 120 present included 75 students.

ITHACA SECTION

A joint meeting of the Ithaca Section of the Society and the Broome Area Chapter of the New York State Society of Professional Engineers took place in Binghamton on May 10, with 72 present. The feature of the occasion was a talk by Maj. G. J. Nold, district engineer for the Corps of Engineers, U. S. Army, whose topic was flood control. Major Nold emphasized watershed conditions and touched briefly on the work in progress in the central New York area.

KANSAS CITY (MO.) SECTION

On May 19 members of the Kansas City Section gathered for the last meeting before the summer recess. Following dinner and a business session Charles A. Haskins, chief engineer and architect of the Missouri State Building Commission, spoke on the state building program of Missouri, pointing out the fact that, through the cooperation of federal agencies, the state will soon complete a $17,000,000 building program that will place its hospitals and prisons in the front rank of model institutions. There were 27 present.

KANSAS STATE SECTION

A number of Student Chapter members were among the 85 present at the May 13th meeting of the Kansas State Section, which took place at the Hotel Kansan in Topeka. Two Student Chapter members—Sanford D. Blattner and N. Souder—were honored at this session as outstanding students and awarded the Section's prizes of membership in the Society. The speaker of the occasion was T. R. Agg, Director of the Society, who gave a talk on "Collective Bargaining Among Engineers."

LOS ANGELES SECTION

Following its annual custom, the Los Angeles Section held its May meeting at the California Institute of Technology in Pasadena, where it was entertained by the Student Chapter at the Institute. Late in the afternoon Student Chapter members conducted groups of Section members to points of interest in the laboratories. Dinner was then served to 211 members, students, and guests, after which the students presented a musical program. Following a brief address of welcome by Dr. R. A. Millikan, Dr. Robert T. Ross, professor of psychology at Stanford University, gave a talk on "Psychology and Engineering." The design of the dome of the Palomar Mountain observatory was discussed by Dr. Ernest Sechler, of the Institute, while Mark Serrurier described the construction of the observatory and exhibited a number of lantern slides showing all stages of construction.

METROPOLITAN SECTION

The annual "Effective Speaking Contest" was the feature of the May meeting of the Metropolitan Section, which was held in the Engineering Societies Building on May 18. This contest, which was sponsored by the Junior Branch of the Section, resulted in the award of a first prize of $15 to Alan Lee Slaton and of a second prize of $10 to Eugene Quiriconi. A motion picture of Grand Coulee Dam, showing the lands which will be irrigated by the canal system and the construction details to date, was enjoyed. The annual election of officers resulted as follows: R. E. Bakenhus, president; J. C. Riedel, vice-president for one year; D. G. Edwards, vice-president for two years; and William J. Shea, secretary. After brief remarks by Admiral Bakenhus and Harold W. Hudson, retiring president of the Section, the meeting was adjourned in favor of refreshments and a social hour. The attendance was 350.

The winners of the Metropolitan Section award of Junior membership in the Society are Howard McCrodden, Frederick Lehman, William J. Hoffman, Sanford Koretsky, John E. Duberg, Joseph Machay, Melville H. Lyman, Jr., and Jack C. Radcliffe.

MID-MISSOURI SECTION

A technical meeting of the Mid-Missouri Section was held in Rolla on April 9. Following dinner, a certificate of life membership in the Society was presented to Elmo G. Harris. Then a review of the past three issues of CIVIL ENGINEERING was given by Walter F. Breuer. The principal address of the evening was delivered by

Dean Johnson, of the University of Missouri, who discussed the place of the engineer in the social, economic, and industrial life of the day. The attendance included a group of students from the Missouri School of Mines and Metallurgy.

MID-SOUTH SECTION

A two-day session of the Mid-South Section took place in Little Rock, Ark., on May 5 and 6. The speakers on the technical programs were George C. Branner, state geologist of Arkansas; E. L. Wales, engineer of materials and tests for the Arkansas State Highway Department; T. A. Middlebrook, senior engineer of the Board of Engineers for Rivers and Harbors; and Ralph B. Hanson, assistant engineer in charge of the soils laboratory of the Little Rock District of the U. S. Engineer Office. Other technical features of interest were motion pictures of Alum Fork Dam, followed by an inspection trip to the site of the project, and inspection trips to the Little Rock water supply system and the auxiliary reservoir and filter plant. A joint luncheon with the Little Rock Engineers' Club and the Arkansas Engineers' Club was held on the first day, the speaker being R. E. Overman, mayor of Little Rock. The speaker at the annual banquet was R. D. Adams. During the annual election of officers the following were elected to serve for the coming year: William E. Elam, president; Paul C. Gauger, vice-president; and Robert C. Gibson, secretary-treasurer.

MILWAUKEE SECTION

There were 40 present at a joint meeting of the Milwaukee Section of the Society and the American Welding Society, which was held at the City Club on April 15. The speaker of the evening was Wilbur M. Wilson, research professor of structural engineering at the University of Illinois, who gave an interesting illustrated talk on recent developments in structural welding. A general discussion of structural welds followed. A number of business matters were considered at the meeting held on May 26, which attracted an attendance of 36. Part of the session was devoted to the presentation of Student Chapter awards, the winners being D. C. Peters and Joseph Van Dyke. Mr. Peters gave a résumé of his paper, which was on the subject of underpinning, and there were talks by F. A. Kartak, dean of engineering at Marquette University, and L. F. Van Hagan, professor of railway engineering at the University of Wisconsin.

NASHVILLE SECTION

At a meeting held on May 10 the Nashville Section elected the following officers for the coming year: S. A. Weakley, president; L. R. Currey, vice-president; and W. T. St. Clair, secretary-treasurer. W. A. Coolidge, the Section's delegate to the Local Sections conference held at Jacksonville, gave a report on the meeting, and a round-table discussion of engineering problems concluded the evening. There were 15 present. On May 20 the Section joined the Vanderbilt University Student Chapter in holding a dinner meeting. The feature of this occasion was the reading of the papers prepared by Student Chapter members in the annual prize competition.

NEW MEXICO SECTION

Discussion of Section matters occupied part of the May meeting of the New Mexico Section, which was held in Santa Fé on the 17th. Later in the evening a talking motion picture showing the construction of the San Francisco–Oakland Bay Bridge was enjoyed through the courtesy of the American Steel and Wire Company. There were 15 at the business session and a considerably larger number at the showing of the film.

NORTHEASTERN SECTION

A joint meeting of the Northeastern Section of the Society, the Boston Society of Civil Engineers, and the Engineering Societies of New England took place in Cambridge, Mass., on April 27. The speaker of the evening was John C. Page, commissioner of the U. S. Bureau of Reclamation, who gave an interesting talk on "The National Conservation Program." In connection with his talk, there were sound motion pictures depicting the construction of Boulder Dam and other projects for the reclamation of arid parts of the West. An animated discussion followed the talk and motion picture.

NORTHWESTERN SECTION

The list of 68 present at the May 17 meeting of the Northwestern Section included 38 members of the University of Minnesota Student Chapter. Several committee reports were heard, and Section prizes were presented to Kenneth W. Person and Mark W. Olson, both of the University of Minnesota. After entertainment by a trio from the Student Chapter Bernard Blum, chief engineer of the Northern Pacific Railroad, was introduced. Mr. Blum gave an interesting account of the flood and bridge clearance controversy at Wibaux, Mont.

PHILADELPHIA SECTION

Soil mechanics, the subject of the April 20th meeting of the Philadelphia Section, was the inspiration for a number of interesting papers. The first speaker was Lazarus White, chairman of the Society's Committee on Foundations, who brought greetings to the Section's newly organized Committee on Foundations. The speakers on the technical program were Gregory P. Tschebotareff, assistant professor of civil engineering at Princeton University; Charles A. Flanagan, chief of the Philadelphia Bureau of Building Inspection; and Chester A. Hogentogler, senior highway engineer of the Division of Tests, U. S. Bureau of Public Roads. Prof. Scott B. Lilly was chairman of the meeting, which attracted an attendance of 90. There were 45 at the dinner preceding the meeting.

Concrete was the topic under discussion at the May 18th meeting of the Section. Following some introductory remarks by Julius Adler, consulting engineer of Philadelphia who acted as chairman, Roy W. Crum spoke. Mr. Crum, who is director of the Highway Research Board of the National Research Council, discussed the many problems still to be solved before perfect laboratory control of concrete becomes an established fact. The second speaker was Charles F. Ball, chief engineer of the Chain Belt Company, Milwaukee, Wis., who presented several reels of motion pictures showing recent methods of mixing, conveying, and placing concrete. There were 70 at the meeting and 31 at the dinner preceding it.

PITTSBURGH SECTION

The annual election of officers of the Pittsburgh Section took place on May 12. These are Charles M. Reppert, president; Lewis W. McIntyre, vice-president; and Charles B. Stanton, secretary-treasurer.

PORTLAND (ORE.) SECTION

There were 65 present at the June 3d meeting of the Portland (Ore.) Section. A symposium on "Bridges on the Oregon Highway System" was given by G. S. Paxson, bridge engineer for the Oregon State Highway Commission. Mr. Paxson was assisted in his presentation by the following members of the Commission: O. A. Chase, designing engineer; M. Stephenson, construction engineer; and E. G. Ricketts, maintenance engineer. At a meeting held on May 20 the prize winners in the annual Student Chapter contest for the best technical papers were announced. These were Thomas N. Creacy and Holley A. Cornell. Honorable mention was given to Frank Marks and Ed Gray. There were about 50 present.

PROVIDENCE SECTION

The Providence Section held a meeting at Rhode Island State College in Kingston, R.I., on May 4. The winning papers in the annual Student Chapter competition were presented at this time, the first award going to Charles Soloman for his paper on "The Development of Sewage Disposal," and the second to Edgar Sanborn for his paper on "The Use of Continuous Structures for Bridges." Both are students at Rhode Island State College. It was resolved at the meeting to submit names of engineers to the governor for appointment to the Board of Professional Engineers for the State of Rhode Island. There were 14 members of the Providence Section present at this gathering.

The Providence Section held its annual dinner and meeting at the University Club on May 25, with 30 present. The guest speakers included Arthur M. Dean, Director of the Society; Sydney Wilmot, manager of publications of the Society, who described the work and growth of the publications department; and Frank E. Fahlquist, geologist in the U. S. Engineer Office at Providence. Mr. Fahlquist spoke on "The Geology of New England and Its Relation to Flood Control," illustrating his lecture with lantern slides. During the business session the following officers were elected for the coming year: William R. Benford,

chairman; Frank W. Stubbs, vice-chairman; and Frederick H. Paulson, secretary-treasurer.

SACRAMENTO SECTION

Members of the Sacramento Section enjoyed their customary luncheon meetings each Tuesday in May. On the 3d business matters were discussed, and A. W. Copley, Pacific Coast manager of the Westinghouse Electric and Manufacturing Company, spoke. Mr. Copley discussed the new 200-in. telescope to be erected on Mt. Palomar, near San Diego, when it is completed. The attendance was 96. On May 10 the speaker was G. H. P. Lichthardt, senior chemical testing engineer of the materials and research laboratory, Division of Highways, California State Department of Public Works. The speaker at the session held on May 17 was John B. Leonard, chief of the division of roads and bridges of the Golden Gate International Exposition. On May 31 A. A. Eremin, associate bridge engineer in the California State Department of Public Works, gave an interesting talk on the projected tunnel under the English Channel between England and France, which was first proposed in 1802. A dinner meeting was substituted for the usual luncheon on May 24, the attendance being 110. The speakers on this occasion were L. B. Chambers, colonel, Corps of Engineers, U. S. Army, and district engineer for the Sacramento area; and Bruce B. Hill, of the Army Air Corps.

SAN DIEGO SECTION

In place of the usual dinner meeting, the San Diego Section made a trip to the Palomar Mountain Observatory on April 24. After a picnic luncheon B. A. Hill, who is resident engineer on the construction of the observatory, conducted the group through the observatory, giving a short talk on the various phases of the work. About 35 members and guests made the trip. Following the May dinner meeting, which was held on the 26th, the members of the Section adjourned to the electric generating plant of the San Diego Gas and Electric Company. Through the courtesy of H. A. Noble, assistant superintendent of the plant, the group was taken on a specially-conducted tour. Since the equipment had been described at one of the Section meetings, all were eager to make the trip.

SEATTLE SECTION

The annual joint dinner meeting of the Seattle Section and the University of Washington Student Chapter took place at the university on May 4, with 53 present. Frederick C. Smith, assistant professor of civil engineering at the university, acted as toastmaster and introduced the guests, the officers of the Student Chapter, and the students who presented papers in the annual competition for the Section award. The contest resulted in the award of prizes to Giro Kubo and Howard Harstad. Walter R. Engstrom, president of the Section, spoke briefly concerning the annual get-together with the Student Chapter and urged the students to attend the meetings of the Section.

SPOKANE SECTION

A special luncheon meeting of the Spokane Section took place on May 20 to accommodate the Section visitors in attendance at a session of the American Water Works Association. The feature of the occasion was a talk by E. Vaughn Klein, chairman of the Columbia Basin committee of the Spokane Chamber of Commerce. Mr. Klein discussed the Columbia Basin project, emphasizing its irrigation aspects. There were 39 present.

SYRACUSE SECTION

There were 21 present at the annual dinner meeting of the Syracuse Section, which was held on May 16. During the business session it was voted to revise the Section dues. The annual election of officers also took place, resulting in the election of Henry Throop as president and of Albert H. Stevenson as vice-president for two years. The terms of S. D. Sarason as vice-president and of M. H. Sturtevant as secretary-treasurer will expire in 1939. Nelson F. Pitts, city engineer and chief engineer of the Syracuse Grade Crossing Commission, addressed the meeting briefly, and Lloyd T. Cheney, president of the Syracuse University Student Chapter, also spoke.

TACOMA SECTION

An interesting film entitled "Trees and Men" was enjoyed at the May meeting of the Tacoma Section. This was presented by Walter Ryan, chief engineer of the Weyerhaeuser Timber Company, who supplemented the film with a talk on logging engineering. A report on the Spring Meeting of the Society, given by Ross K. Tiffany, Director of the Society, was also enjoyed, as was Mr. Tiffany's account of his experience in flying to and from the meeting. There were 51 present at the dinner, while about 20 additional guests came in for the program.

TENNESSEE VALLEY SECTION

In May the Asheville Sub-Section of the Tennessee Valley Section participated in the organization of an engineering society to be known as the Engineers Club of Western North Carolina. The organization is so set up that meetings are to be considered joint meetings of the local groups of the Founder Societies, functioning as one organization and yet keeping their individual identity. The Asheville Sub-Section played an active part in organizing this club. After the details of organization had been settled, Alfred W. Quick, chief engineer of the Fidelity Insurance Company, spoke.

The Chattanooga Sub-Section held a dinner meeting on May 11, with 37 present. The list of speakers included H. L. Fruend, president of the Tennessee Valley Section, who reported briefly on the Spring Meeting of the Society; Ford L. Wilkinson and N. W. Dougherty, professors of mechanical and civil engineering at the University of Tennessee, respectively; and Dr. Harder, of the Tennessee Valley Authority.

The Knoxville Sub-Section held its regular meeting on June 2, with 58 present. The feature of the occasion was a talk by Charles F. Ellis, of the Tennessee Valley Authority, who gave a résumé of the relationship of air conditioning problems and engineering design. After considerable discussion of this talk, Mr. Fruend, in behalf of the Tennessee Valley Section, presented awards to the two outstanding graduates from the University of Tennessee. These were Charles T. Bagley and James M. Tuttle.

Eight were present at the May meeting of the Muscle Shoals Sub-Section of the Tennessee Valley Section, which was held at Wilson Dam on the 12th. Following a brief business discussion, Felix Truss, civil engineer for the Tennessee Valley Authority, discussed the methods used by the Authority in its various reservoir surveys and the degree of accuracy obtained.

TOLEDO SECTION

The list of 35 present at the June 3 meeting of the Toledo Section included Henry E. Riggs, President of the Society, and Louis E. Ayres, Director. Following dinner and a short business meeting, Dr. Riggs spoke, giving a concise description of the workings of the Society and stressing the attention given by the Society to Local Sections during recent years. Mr. Ayres then commented briefly on the coming meeting of the Seventh District of the Society, to be held at Houghton, Mich., August 25–27.

VIRGINIA SECTION

On April 29 and 30 the Virginia Section participated in a joint spring meeting of state chapters of the American Institute of Electrical Engineers, the American Institute of Architects, and the American Society of Mechanical Engineers, and the Engineers Club of Hampton Roads, which took place in Norfolk. The list of speakers at the technical sessions included Walter R. Crowe, C. H. Cowgill, Merrill C. Lee, Wilson T. Howe, J. H. Cornell, and G. G. Greulich. The master of ceremonies at the luncheon was Ernest W. Farley, while John N. Sebrell, Jr., gave the address of welcome. W. F. Nimmo presided at the dinner, and the after-dinner speaker was A. F. Loewe. The second day was devoted to an inspection trip to the Naval Operating Base, which was followed by luncheon at the Seashore State Park and a visit to other places of interest at Cape Henry and Virginia Beach.

WEST VIRGINIA SECTION

The spring meeting of the West Virginia Section was held in Parkersburg, W.Va., on April 1. Following dinner and a brief business session, L. F. Bellinger, Vice-President of the Society, was introduced and spoke on the subject of "Engineering Reminiscences." The next speaker was T. O. Mason, honor student at West Virginia University, who urged the extension of engineering courses to a six-year period to correspond with the system of interneship in the medical profession. The concluding feature was a sound motion picture depicting the construction of the Golden Gate Bridge, which was shown by A. G. Olsen, of Pittsburgh, Pa.

ITEMS OF INTEREST

Engineering Events in Brief

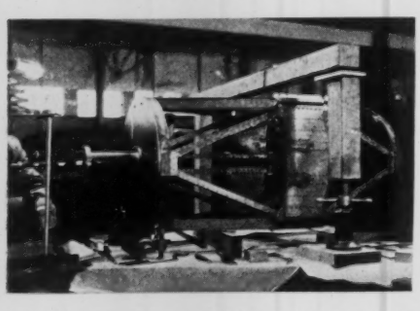
CIVIL ENGINEERING for August

AN IMPORTANT contribution to structural research is scheduled for presentation in the August issue of CIVIL ENGINEERING—"Fatigue Tests of Riveted Joints," by Wilbur M. Wilson, M. Am. Soc. C.E. The article is an abridgment of the paper presented by Professor Wilson at the Annual Meeting in January of this year.

"The members of steel structures such as bridges," writes Professor Wilson, "are not subjected to as frequent repetitions of stress as the moving parts of machines. But some of the early steel bridges have some members that have been subjected to a few million stress cycles, and some of these members have failed. This, together with the experience of the mechanical engineer with machine parts, has led the structural engineer to consider fatigue as a possible cause of failure of structural members. The fact that the size and shape and the condition of the surface of small fatigue specimens greatly affects their fatigue strength, indicated that tests of small machined specimens were of little value in determining the fatigue strength of structural members. What appeared to be needed was tests of specimens which are in reality fabricated structural members as large as it is feasible to test. This paper is a report of tests of this character."

Interesting problems in the design of WGY's new antenna tower, or vertical radiator, are also to be reported in August by E. G. Semon, Assoc. M. Am. Soc. C.E. The tower is 625 ft in height and is supported by a single porcelain insulator. Stability is provided by two sets of guys.

From California, Mark Serrurier, Assoc. M. Am. Soc. C.E., contributes a fascinating account of the structural engineer's part in designing the 200-in. tele-



SET-UP FOR TESTING MODEL OF TUBE OF 200-IN. TELESCOPE

scope now nearing completion at the Mt. Palomar observatory (California Institute of Technology).

The remaining articles, it is expected, will include a number of papers on irrigation, sewage disposal, transportation, and surveying, from the Annual Convention of the Society at Salt Lake City.

Yes, There Still Is Romance in the Profession

ACCORDING to a press dispatch, the legality of the recent marriage of an opera star and an orchestra leader was challenged on the grounds that the license had been issued in one township and that the diva's estate, where the ceremony was performed, was in another.

The bride was not a bit perturbed. An attorney explained that she had taken the precaution to obtain an "engineer's map" of her estate, which clearly showed the township line cutting across the property. The main house obviously was out of bounds, but the summer house, scene of the wedding, was on the right side of the line.

It looks now like a problem for the tax assessor.

Benjamin Franklin Attends Dedication of Benjamin Franklin Memorial

As the Society's representative, Benjamin Franklin, M. Am. Soc. C.E., attended the dedication in Philadelphia, on May 19–21, 1938, of the Benjamin Franklin Memorial. Mr. Franklin supplies the following account of the memorial in honor of the famous Revolutionary statesman, scientist, and business man and of the dedication ceremonies.

THE Benjamin Franklin Memorial Building had its inspiration in the Poor Richard Club of Philadelphia, an organization of advertising men, publishers, and business men of kindred interests, who had adopted the name of Benjamin Franklin's well-known publication. Cyrus K. Curtis, late publisher of the *Saturday Evening Post* and a member of the club, became greatly interested in this movement, and in conjunction with Dr. Howard McClenahan, who at that time was secretary of the Franklin Institute, organized a committee known as Benjamin Franklin Memorial, Inc., to collect funds for a memorial building and to push the project to completion.

For this purpose the city of Philadelphia generously gave a plot of ground at 20th Street and the Parkway, amounting to about 4.4 acres. Through the generosity of public-spirited citizens of Philadelphia and vicinity the sum of $5,070,000 was raised, Mr. Curtis himself being a very liberal contributor. This sum proved sufficient to erect the magnificent and enduring structure now known as the Benjamin Franklin Memorial. The building houses many activities. It includes the Fels Planetarium, the gift of Samuel S. Fels, opened in November 1933, which each month gives a new demonstration of the heavens covering periods from before the birth of Christ to the present time. The Museum contains thousands of scientific marvels, the earliest inventions being shown together with their latest developments. Among them are included railroad and electrical engineering appliances, chemical developments, textile manufactures, and all classes of exhibits that will prove interesting to the school boy, the college student studying for a profession, the business man, and the manufacturer seeking the latest knowledge on the subject in which he is especially interested.

Dedication of the Memorial Building was delayed until the completion of the heroic statue of Benjamin Franklin—the gift of Robert McLean, late publisher of the *Evening Bulletin*. The statue, of white marble, is the work of the celebrated American sculptor, James Earle Frazer.

For the opening ceremony on May 19, the many distinguished guests were escorted to the Memorial Building by the First City Troop of Philadelphia, a Colonial military organization. The program included an oration by the Honorable George Wharton Pepper, who directed attention to the many and varied institutions founded or inspired by Dr. Franklin, to his predominant qualities as a business man, a scientist, a statesman, a diplomat, and an inventor; and emphasized that the Memorial Building was the only one which could rightly be called his permanent home. Following Mr. Pepper's speech, there was an address by the French Ambassador, Count René Doynel de Saint-Quentin, who dwelt mainly on the esteem the French people entertained for Franklin, and the cordial relations he had established between France and the United States.

On May 20 there was a series of lectures on pure science, the general theme being "Franklin—Philosopher and Educator." In the evening there was an academic procession of delegates, medalists, and the recipients of degrees to be conferred by the University of Pennsylvania. Following this, the Franklin Institute, through its president, Philip C. Staples, presented the Longstreth, Clark, Henderson, Levy, Potts, Cresson, and Franklin medals. The latter, which is the highest award made by the Franklin Institute, was presented to William Frederick Durand, Ph.D. LL.D., of Stanford University Calif.; and to Charles August Kraus, Ph.D., of Brown University, Providence, R.I.

The third day of the ceremonies featured lectures on applied science, with the theme, "Franklin—Printer and Business Man." The dedication was concluded that evening with a banquet attended by some eight hundred persons. The first speaker was the Hon. Roland S. Morris, president of the American Philosophical Society, who dwelt upon Franklin's various activities; and the second was ex-President Herbert C. Hoover, who wittily contrasted Franklin's teachings and advice with present-day practices.

Honorary Degrees Awarded

DURING THE commencement season each year honorary degrees are awarded to certain engineers who have made notable contributions to the profession. Word of several members of the Society thus honored this year has reached Headquarters, and the list of these follows. Doubtless there are others of whom the Society has not yet heard.

GANO DUNN, M. Am. Soc. C.E., Doctor of Science, Columbia University; Doctor of Science, Rutgers University.

LINCOLN ELLSWORTH, Assoc. M. Am. Soc. C.E., Doctor of Science, Rutgers University.

CHARLES B. HAWLEY, M. Am. Soc. C.E., Doctor of Engineering, Case School of Applied Science.

JOHN B. HAWLEY, M. Am. Soc. C.E., Doctor of Science, Texas Christian University.

CHARLES A. POHL, M. Am. Soc. C.E., Doctor of Engineering, Clarkson College of Technology.

J. C. STEVENS, M. Am. Soc. C.E., Doctor of Engineering, Oregon State College.

Brief Notes from Here and There

A SECTIONAL meeting of the World Power Conference will be held in Vienna, August 25 to September 2 of this year. Papers and discussions will deal with the supply of energy for agriculture, small-scale industries, household purposes, public lighting, and electric railways. Program details and registration forms can be secured from the executive committee of the United States national committee of the conference, 4 Irving Place (Room 1409-S), New York, N.Y.

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POLICE departments undertaking traffic engineering work now have a guide to standard procedure through the publication of a handbook entitled *Traffic Engineering and the Police*. The handbook has been published jointly by the National Conservation Bureau and the Safety Division of the International Association of Chiefs of Police, and deals with elementary traffic engineering techniques designed to reduce traffic accidents and congestion through the control of physical hazards. It is the work of Harold F. Hammond, Jun. Am. Soc. C.E., director of the Traffic Division of the National Conservation Bureau, and Lieut. Franklin M. Kreml, director of the Safety Division of the International Association of Chiefs of Police and of Northwestern University Traffic Safety Institute. Though intended for police use, it is expected to be equally helpful to other municipal departments engaged in traffic engineering work.

Single copies will be sent to municipal and state officials upon request to the National Conservation Bureau, 60 John St., New York, N.Y. Others may obtain copies at 40 cents each.

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A PROGRAM of all-day conferences on strength of timber and concrete will be held at the Massachusetts Institute of Technology, Cambridge, Mass., on July 7 and 8. Among the problems to be discussed relating to timber are modern wood construction and its relation to specification of lumber products; destroying agencies; and methods of preventing deterioration. Discussion subjects relating to concrete include the relation of cement composition to quality of concrete; methods of proportioning, mixing, and placing, and their effect on strength; Poisson's ratio; prevention of vibration in foundations; and conformity of design assumptions and actual conditions in masonry dams. Further information can be obtained from Prof. J. M. Lessells, of the Department of Mechanical Engineering of the Institute.

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LONDON FRIENDS of the late William Cawthorne Unwin, Hon. M. Am. Soc. C.E., are renewing their efforts to amplify the endowment for the Unwin Scholarship, awarded annually at the Central Technical College, London, and to provide a suitable memoir of Dr. Unwin's life. An American committee, which included three representatives of the Society, some time ago succeeded in raising £100 for this fund. That committee was discharged in October 1937, and those still wishing to contribute are asked to send their gifts to E. G. Walker, honorary treasurer, 82 Victoria St., London S.W. I, England.

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THE Seventh International Management Conference meets in Washington, D.C., September 19–23, 1938. At the general sessions, addresses will be given in pairs to introduce the American and foreign points of view on social and economic aspects of management. The six series of simultaneous technical sessions will provide for a discussion of recent developments in management techniques, pertaining separately to administration, production, distribution, personnel, agriculture, and the home.

The fee for each regular attendant at the Congress is $10. Programs and further details can be secured from Nathaniel W. Barnes, Executive Secretary, Room 1201, 347 Madison Avenue, New York, N.Y.

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ROAD maintenance problems, use of asphaltic materials, roadside improvement, and standardization of safety signals, all had their place in the program of the first Arizona roads and streets conference, held in March 1938 under the joint auspices of the University of Arizona, the state highway department, and the Local Section of the Society. An 81-page mimeographed volume containing the papers and some of the discussions has just been prepared, and can be obtained at 50 cents a copy from E. V. Miller, Assoc. M. Am. Soc. C.E., general chairman, Arizona Highway Department, Phoenix, Ariz.

NEWS OF ENGINEERS

Personal Items About Society Members

KEYES C. GAYNOR, consulting engineer of Sioux City, Iowa, has been appointed to the post of city engineer of Sioux City.

CHARLES W. BRITZIUS, until recently connected with the Minnesota State Highway Department, with headquarters in St. Paul, Minn., has taken over the practice of the Quincy A. Hall Testing Laboratories under the name of Twin City Testing and Engineering Laboratories.

CHARLES R. PETTIS, colonel, Corps of Engineers, U. S. Army, has been put in charge of the U. S. Engineer Office at Detroit, Mich. Colonel Pettis will also continue to direct the U. S. Lake Survey Service at Detroit.

EDWARD ANDERBERG is now chief of the Planning Section of the WPA for New York City.

FRED E. FOSS, head of the department of civil engineering at Cooper Union, will be retired at his own request at the end of the present academic year. Professor Foss has been teaching civil engineering for over fifty years, twenty-nine of which were spent at Cooper Union.

JOSEPH H. EHLERS, formerly liaison officer at the Public Works Administration, announces his return to private practice as engineering and industrial consultant at 4000 Cathedral Avenue, Washington, D.C. Mr. Ehlers will also serve as Washington representative for engineers, contractors, and public bodies.

D. F. GIBONEY, who was director in charge of the Five Borough Department of the WPA, New York City, has been appointed chief of the Supply Section.

ARTHUR G. HOLT retired on June 1 as assistant to the chief engineer of the Chicago, Milwaukee, St. Paul and Pacific Railroad Company and is making his home in Evanston, Ill.

RAY C. BRUMFIELD, assistant professor of civil engineering at Cooper Union, has been appointed acting head of the civil engineering department for 1938–1939.

DAVID STANDLEY was recently appointed director of the Manhattan Field Office of the WPA, New York City. He was formerly assistant director of the City-Wide Department.

ARTHUR ALVIN JOHNSON is now field engineer for the Rural Electrification Administration of the State of Wisconsin. Previously Mr. Johnson was assistant engineer in the U. S. Engineer Office at Zanesville, Ohio.

JAMES G. STEESE, of San Antonio, Tex., has been elected president of Slate Creek Placers, Inc., and will soon leave for Alaska to supervise that corporation's gold-mining activities during the open season.

CONSTANTIN P. MELIORANSKY, until recently assistant engineer for the New York Central Railroad, has accepted a similar appointment in the engineering department of the New York City Board of Water Supply.

THOMAS H. JONES, formerly deputy city-wide engineer for the WPA, New York City, has been made deputy field director in Queens.

PAUL M. HOLMES, designing engineer for the division of engineering and construction of the city of Columbus, Ohio, has just been installed as president of the Engineers Club of Columbus.

D. JACKSON FAUSTMAN is now assistant traffic engineer of Sacramento, Calif.

HORACE A. JOHNSON has resigned as assistant engineer for the U. S. Bureau of Reclamation at Yuma, Ariz., to enter the employ of the U. S. Engineer Department as junior engineer, with headquarters in Los Angeles, Calif.

NATHAN H. STURDY, formerly consulting engineer of Buffalo, N.Y., has accepted a position as structural engineer with the U. S. Housing Authority. He is located in Washington, D.C.

WALTER G. SCHULZ, until recently junior bridge engineer on the construction of the San Francisco–Oakland Bay Bridge, has become assistant hydraulic engineer in the Division of Water Resources of the California State Department of Public Works. His headquarters are in Sacramento, Calif.

ARTHUR E. HASS is now in the engineering division of the Cities Service Oil Company at Bartlesville, Okla.

SAMUEL SHULITS, assistant professor of mechanics and hydraulics at the Colorado School of Mines, has been appointed lecturer in hydraulics for the summer session at the University of Iowa.

A. D. WOLFF, JR., has been promoted from the position of assistant engineer of the New York terminal district of the New York Central Railroad to that of designing engineer for the same organization. He is still located in New York.

L. C. TSCHUDY, for the past three years regional engineer for Region 9 of the U. S. Soil Conservation Service at Rapid City, S.D., has been transferred to Region 7 and will be in charge of the engineering activities of the Service for Kansas, Nebraska, and Oklahoma. His headquarters are at Salina, Kans.

B. E. PHELPS, construction engineer for the La Porte District of the Indiana State Highway Commission, has been appointed by the State Board of Health as a member of a special commission to supervise the construction of sewers and a disposal plant for the city of Gary.

LEONARD D. WOOD, JR., is now in San Juan, Puerto Rico, where he is acting as sales engineer for the Armco International Corporation. He was formerly with the American Rolling Mill Company, at Middletown, Ohio.

RAYMOND J. ROSENBERGER has been transferred, by request, from the Public Works Administration in Washington, D.C., to the Federal Power Commission, with headquarters in New York City.

CHARLES HUNNELL, JR., was recently promoted from the position of district construction engineer for the Indiana State Highway Commission to that of assistant engineer of road construction.

EARL J. BILLINGSLEY, formerly inspector of catenary construction for the Pennsylvania Railroad, Philadelphia, Pa., is now a junior engineer in the Corps of Engineers, U. S. Army, with headquarters in the U. S. Engineer Office at Pittsburgh, Pa.

AARON I. RAISMAN recently retired on a pension after thirty-eight years with the New York City Board of Transportation and its predecessors. For the past twenty years he was chief designing engineer for the Board.

ARTHUR R. SMITH has established a consulting practice in general construction materials at 165 West Wacker Drive, Chicago, Ill., under the firm name of Engineering Service.

DECEASED

SHELDON ABBOTT BROWN (Jun. '34) was killed on April 15, 1938, by a rolling boulder at the entrance of a highway tunnel near Idaho Springs, Colo., where he was taking measurements for the tunnel construction. Mr. Brown, who was 27, had been with the Colorado State Highway Department as a draftsman and instrumentman since his graduation from the University of Colorado in 1932.

WALTER CHARNLEY (M. '13) who was with the Sao Paulo Tramway, Light and Power Company, Sao Paulo, Brazil, died on March 9, 1938. He was 55. Mr. Charnley's early experience was in railroad engineering work in this country and Mexico, and from 1912 to 1917 he was engineer of construction for the Sao Paulo Tramway, Light and Power Company. During the war he was in the United States, where he was commissioned first lieutenant in the 70th Regiment. In 1919 he returned to Sao Paulo in the same capacity.

WALTER LEAKE CLARKSON (M. '21) civil engineer of Bayonne, N.J., died in that city on May 11, 1938, at the age of 66. From 1890 to 1899 Mr. Clarkson was with Smith and Weston, of Bayonne, N.J., and from 1899 to 1905 he was in entire charge of office and field work for the city engineer of Bayonne. From the latter year on he was in private practice as a civil engineer and surveyor on work for the Texas Company, the Standard Oil Company, and similar corporations. At times he also served as city engineer of Bayonne and borough engineer for Bound Brook.

EDGAR DUDLEY CRUISE (M. '13) died on June 5, 1938, as the result of injuries suffered in an automobile accident. He was 71. For several years Mr. Cruise was in full charge of railroad location in Mexico for the Southern Pacific Railway, and he also served as principal locating engineer and chief engineer for the Comision Nacional de Caminos. For a number of years Mr. Cruise was with the state highway departments—in Tennessee, North Carolina, and finally in New Mexico.

JAMES HERVEY DINGLE (M. '16) city engineer of Charleston, S.C., died on June 3, 1938, at the age of 69. Mr. Dingle spent his entire career in the employ of the city, starting work as assistant city engineer in 1893 and becoming city engineer a year later. During his incumbency sixty miles of paved streets were laid, and the city sewer system, the Boulevard sea wall, and many other public improvements were built.

ROBERT A. GREENFIELD (M. '10) retired architect and engineer, died in Geneva, N.Y., on May 15, 1938, at the age of 65. For seven years Mr. Greenfield was in charge of the U. S. Treasury Department construction, including the Custom House in New York City. He also did work on the general post office in New York, the post office in Pittsburgh, and on other buildings throughout the country. During the war Mr. Greenfield served with the 303d Engineers in France, with the rank of major.

CHARLES COMSTOCK HOPKINS (M. '90) consulting engineer of Rochester, N.Y., died there on April 30, 1938, at the age of 78. From 1887 to 1910 Mr. Hopkins was a member of the firm, Knight and Hopkins, and of the Stanwix Engineering Company, of Rome, N.Y. In 1910 he went to Rochester, where he practiced as consulting hydraulic and sanitary engineer. Mr. Hopkins was noted for having designed many water-works structures in New York State.

LARS RASMUS JORGENSEN (M. '14) consulting hydroelectric engineer of Berkeley, Calif., died in that city on May 8, 1938, at the age of 62. A native of Denmark, Mr. Jorgensen came to this country as a young man. From 1905 to 1907 he was hydroelectric engineer for the Pacific Gas and Electric Company, and from 1907 to 1914 a member of the firm, F. G. Baum and Company. From 1914 on he had his own firm, the Constant Angle Arch Dam Company, in San Francisco. Mr. Jorgensen was the inventor of the constant angle arch dam.

OTTO COFFEEN FITZ RANDOLPH (Assoc. M. '19) president and treasurer of Otto

Randolph, Inc., Chicago, Ill., died on May 8, 1938, at the age of 47. Mr. Randolph's career included experience as construction engineer for the Timpken Detroit Axle Company and as district manager in Chicago for the H. K. Ferguson Company, of Cleveland. For a number of years he was president and treasurer of the general contracting firm, Otto Randolph, Inc. During the war Mr. Randolph served overseas with the 16th Engineers, his final promotion being to the rank of major.

ROBERT REIMANN (M. '18) of Baltimore, Md., died on April 12, 1938. Mr. Reimann, who was 56, was born in Denmark. Coming to this country in 1904, he entered the employ of the Baltimore and Ohio Railroad, where he remained for twenty-eight years, retiring in 1932. During this period he was, successively, draftsman and transitman; head draftsman; and assistant engineer in charge of surveys, supervising the work of the office force and all field parties.

EMORY SUDLER (M. '25) of Washington, D.C., died at his home in that city on April 21, 1938, at the age of 68. After early experience with the Baltimore and Ohio and the Louisville and Nashville railroads, Mr. Sudler was for many years prominently connected with the water department of Baltimore, Md. Later he was chief engineer for the Ambursen Dam Company, in New York City, retiring from that position in 1929.

WALTER SUTTON SYRETT (M. '17) president of the Grand Haven Terminals Company, Grand Haven, Mich., died suddenly at his home in Glenside, Mich., on May 22, 1938. Mr. Syrett, who was 66, was born and educated in England, coming to this country about forty years ago. In 1916 he established a belt line railway in Grand Rapids, which is now a part of the Grand Western system, and for many years he was president of the Muskegon Utilities Company. In 1934 he became connected with the Grand Haven Terminals Company.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

LUIS VELEZ (M. '16) minister of public works, Caracas, Venezuela, died in 1934, at the age of 76. From 1889 to 1910 Mr. Velez was variously employed in Colombia and Venezuela, and from 1910 to 1914 he was chief engineer and manager on location and construction of the Central Highway of Tachira. In the latter year he became minister of public works of Venezuela, principally on the construction and improvement of ways of communication.

JOHN HERBERT WALLACE (M. '90) of Los Angeles, Calif., died on February 3, 1938. At one time Mr. Wallace was assistant chief engineer for the South Pacific Company, with headquarters in San Francisco. Later he established a consulting practice in the same city, maintaining it for a number of years. He moved to Los Angeles in 1934.

RALPH NORMAN WHEELER (M. '36) of Cocoa, Fla., died at his home there on May 6, 1938, at the age of 64. With the exception of three years as engineer for the T. A. Gillespie Company, Mr. Wheeler was in the service of the City of New York from 1895 to 1931. During this period he worked on water-supply projects for Brooklyn, was in charge of subway construction projects in New York City, and was division engineer in charge of the construction of sixty miles of the Catskill Aqueduct. After the completion of the project in 1918, he was in charge of the operation of the aqueduct and the upkeep of structures.

CHARLES BEATTY WILSON (M. '03) president of the Gould Contracting Company, Honolulu, Hawaii, died on April 8, 1938. Mr. Wilson, who recently received a certificate of life membership in the Society, was 66. For a number of years he was engaged in bridge and tunnel building for various railroad and construction companies, and in 1915 he became vice-president of the Gould Contracting Company, with headquarters in Nashville, Tenn. In 1917 he was made president and general manager. Mr. Wilson was in charge of many construction enterprises for this organization in the South. He went to Hawaii in 1936.

JOSEPH FRANKLIN WITMER (M. '04) retired civil engineer of Elmira, N.Y., died on May 23, 1938, at the age of 79. Beginning in 1895, Mr. Witmer for many years maintained a hydraulic and sanitary engineering practice in Buffalo, N.Y. During this period he designed and built the Akron (Ohio) water works, of which he was later senior assistant engineer. During his last years he had a consulting practice in Elmira, retiring in 1936.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From May 10 to June 9, 1938, Inclusive

ADDITIONS TO MEMBERSHIP

ABDUN-NUR, EDWARD AMIN (Assoc. M. '37), 133 Broadwater St., Billings, Mont.

ALEXANDER, JOE BARKLEY (Assoc. M. '38), Asst. Div. Civ. Engr., Humble Oil & Refining Co., Houston, Tex.

ANDRES, ROBERT WILLIAM (Jun. '38), 1465 Fairmont Ave., St. Paul, Minn.

ATTAWAY, JOSEPH GRADY (Assoc. M. '38), Gen. Contr. (J. G. Attaway Constr. Co.), Statesboro, Ga.

BARBEE, EDWIN WALLACE (Jun. '38), Water Purification Engr., Purification Div., San Francisco Water Dept. (Res., 117 Conrad St.), San Francisco, Calif.

BLACK, HAYSE HENRY (Assoc. M. '38), Asst. San. Engr., State Dept. of Public Health (Res., 1605 South Douglas Ave.), Springfield, Ill.

BLACKWELL, BENJAMIN RICHARD (Jun. '38), Care, Dept. of Hydr. and San. Eng., Univ. of Wisconsin, Madison, Wis.

BLALOCK, JAMES ARTHUR (Jun. '37), Care, Supervisor of Track, P. R. R., Perryville, Md.

BLENDERMAN, WILLIAM EDWARD (Jun. '37), 2550 Creston Ave., New York, N.Y.

BROWN, ARTHUR ORVILLE (Jun. '37), Care, U. S. Bureau of Reclamation, Box 424, Ephrata, Wash.

BRUMAGE, ROBERT CASSIL (Jun. '37), 1401 Kearney, Laramie, Wyo.

CALKINS, JOHN NORMAN (Jun. '37), 712 West Ionia St., Lansing, Mich.

CAMPBELL, ARTHUR (Assoc. M. '37), Public Buildings Commr., City of Newton, Newton (Res., 94 Nehoiden Rd., Waban), Mass.

CARLSON, HARRY (Jun. '38), Asst. Engr., U. S. Engr. Office (Res., 1318 Charles St.), St. Paul, Minn.

CAULEY, PHIL WILSON (Jun. '37), Fordwick, Va.

CLARY, JOHN NORWOOD (Assoc. M. '38), Bridge Designer, Bridge Dept., State Dept. of Highways (Res., 1922 Grove Ave.), Richmond, Va.

COLLINS, JOHN GRIFFIN (Jun. '37), Crescent Lake, Ore.

COURTNEY, NEVILLE COLE (M. '38), Structural and Hydr. Engr., Joel D. Justin, Philadelphia, Pa. (Res., 306 Haakon Rd., Brooklawn, Gloucester, N. J.)

CUDWORTH, ARTHUR GEORGE (Jun. '38), Structural Engr., Western Portland Cement Assoc., 522 Boston Bldg. (Res., 1590 Elm St.), Denver, Colo.

DISKANT, ROBERT (Jun. '37), 437 North 40th St., Philadelphia, Pa.

DODGE, CLIFFORD FRANCIS, JR. (Jun. '38), Timekeeper, Fiske Cartér Constr. Co., Worcester (Res., 13 Sword St., Auburn), Mass.

DYKTOR, HERBERT GEORGE (Assoc. M. '38), Chf. Industrial Hygiene Engr., St. Louis Health Div., 62 Municipal Courts Bldg. (Res., 6055 Waterman Ave.), St. Louis, Mo.

ENDRES, GEORGE BEN (Jun. '37), 6618 Carleton Ave., Seattle, Wash.

ERICKSON, HAROLD VERNER (Jun. '37), Instrumentman, State Highway Comm., 3013 Stafford Rd., Topeka, Kans.

ERNEST, RALPH NELSON (Jun. '37), 4719 Woodland Ave., Drexel Hill, Pa.

FORERO BENAVIDES, MANUEL GUILLERMO (Assoc. M. '38), (Compañia de Ingenieros Constructores), Apartado 222, Bogota, Colombia.

FOWLER, HAROLD DIX (Jun. '37), with Robert

E. McKee, 913½ South Catalina St., Los Angeles, Calif.

FRASER, ROBERT HAMILTON (Jun. '38), 241 East 52d St., New York, N.Y.

FRENCH, JOHN LAWRENCE (Jun. '38), Junior Engr., U. S. Geological Survey, Care, Georgia School of Technology, Atlanta, Ga.

GILBRETH, JOE CLYDE (Jun. '37), 102 West 18th St., Austin, Tex.

GLEASON, ROBERT JOSEPH (Jun. '37), Junior San. Engr., Dist. Office, State Dept. of Health, 206 Ridge St., Glens Falls, N.Y.

GOETZ, EDGAR AUGUST (M. '38), Advertising Mgr., St. Paul Foundry Co. (Res., 1316 Keston St.), St. Paul, Minn.

GRIFFITH, GEORGE MALCOLM (M. '38), Dist. Engr., Iowa Culvert & Pipe Co., 444 Insurance Exchange Bldg., Des Moines, Iowa.

HARKRIDER, CLOVIS JOSEPH (Jun. '38), Asst. Res. Engr., Insp., PWA (Res., 3029 College Ave.), Fort Worth, Tex.

HEISEL, FREDERICK FRANK (Jun. '38), 105 North Park Ave., Park Rapids, Minn.

HUME, RITCHEY (Assoc. M. '38), Representative of Gen. Office Engr., TVA, Chattanooga, Tenn.

INGWALSON, CARL FREDRICK (Jun. '38), 725 Hamilton Ave., Lorain, Ohio.

JOHNSON, WALTER FELIX (Jun. '38), Asst. Engr., National Bureau of Casualty & Surety Underwriters, Inc. (Res., 31 Mount Hope Pl.), New York, N.Y.

JONES, ROBERT ENDERLIN (Jun. '37), 4725 Pechin St., Roxborough, Philadelphia, Pa.

KESLER, MACK SMITH (Jun. '38), 264 University St., Salt Lake City, Utah.

KIRCHHOFF, ARTHUR AUGUST GERHART (Assoc. M. '38), Capt., Corps of Engrs., U.S.A., Asst. Prof., Coll. of Eng., West Virginia Univ. (Res., 237 South Walnut St.), Morgantown, W.Va.

LAKE, ROBERT WARREN (Jun. '38), Rodman, C. M. St. P. & P. R.R. (Res., 306 West Ave., N.), La Crosse, Wis.

LARNDER, IVOR TULK CHESSON (Assoc. M. '38), Res. Engr., Canadian Niagara Power Co., Ltd., Box 118, Niagara Falls, Ontario, Canada.

LEDYARD, RUSSEL BROCKWAY (Jun. '37), Junior Draftsman, State Highway Dept., 1213 Clarkson St., Denver, Colo.

LEONARD, CHARLES ANTHONY (Jun. '38), Asst. Engr., U. S. Engr. Office, Rock Island, Ill.

LOTHERS, JOHN EDMOND (M. '38), Associate Prof. of Architecture, Oklahoma Agri. and Mech. Coll. (Res., 128 Admiral Rd.), Stillwater, Okla.

MCBROOM, EARL HENRY (Assoc. M. '38), Associate Bridge Designing Engr., State Div. of Highways (Res., 4930 Seventh Ave.), Sacramento, Calif.

MCGEE, JAMES HERMAN TAYLOR (Assoc. M. '38), County Engr., Collier County; Engr.-Supt., Everglades Ry. Light & Power Co.; Asst. to Chf. Engr., Barron G. Collier Interests, Box 95, Everglades, Fla.

MANGASARIAN, RICHARD DICRAN (Jun. '38), Care, Caribbean Petroleum Co., Maracaibo, Venezuela.

MICKELSEN, HENRY ERNST (Jun. '37), 4536 Lake Park Ave., Chicago, Ill.

MILNER, FRANK (Jun. '37), Graduate Asst., Purdue Univ., Joint Highway Research Project, State Highway Comm., School of Civ. Eng., Purdue Univ., West Lafayette, Ind.

MOORE, CLARENCE HILTON (M. '38), Pres., The Aetna Iron & Steel Co. (Res., 2130 Laura St.), Jacksonville, Fla.

MOORE, FREDERIC FINBAR (Jun. '38), 469 Marlborough Rd., Brooklyn, N.Y.

MORTON, JOHN ORDWAY (Assoc. M. '38), Constr. Engr., State Highway Dept., Concord, N.H.

MOTT, THOMAS CLAYTON (M. '38), Chf. Engr. and Mgr., Miller & Lux Inc. and Allied Corporations, Box 205, Los Banos, Calif.

MOYSE, JACK (Assoc. M. '38), Care, State Highway Comm., State House Annex, Indianapolis, Ind.

PAUW, ADRIAN (Jun. '38), 5613 Twelfth Ave., N.E. Seattle, Wash.

PHILIPS, REUBEN LITTLETON (Assoc. M. '38), Bridge Engr., J. B. Klein Iron & Foundry Co. (Res., 2400 North West 13th St.), Oklahoma City, Okla.

PLATT, DORAN STONE, JR. (Jun. '38), Engr., Davis & Platt, Inc., 407 Butternut St., N.W., Washington, D.C.

PLOWE, JASON (Jun. '37), Asst. Bridge Engr., State Div. of Highways, Bridge Dept., Box 91, Colfax, Calif.

PRICHARD, ROBERT LEO (Jun. '38), Res. Engr., J. B. McCrary Co., Inc., Box 68, Abingdon, Va.

PROTZE, HERMAN GUSTAV, JR. (Jun. '38), Engr. in Chg. of Laboratory Work, The Thompson & Lichtner Co., Inc., Boston (Res., 41 Martin Rd., Wellesley), Mass.

PURDOM, PAUL WALTON (Jun. '38), Materials Insp., Middle Georgia Div. of Post Roads, State Highway Dept., Sparta, Ga.

RAGSDALE, THERON WRIGHT (M. '38), Prin. Engr., Asst. Chf. of Operations, Fort Peck Dist., U. S. Engr. Office (Res., 1103 East Kansas St.), Fort Peck, Mont.

RAINE, OLIVER HAMILTON (Jun. '37), Asst. Eng. Draftsman, TVA (Res., 508 Houston St., Apartment 20), Chattanooga, Tenn.

RAMSEY, JAMES BUTLER (Jun. '37), 321 East 48th St., Kansas City, Mo.

REIWITZ, AL ACKLAND (Jun. '37), Structural Designer, H. T. Gettins Co., 268 Thirteenth St. (Res., 1895 Jefferson St.), San Francisco, Calif.

RODHOUSE, THOMAS JACOB, JR. (Assoc. M. '38), Asst. Engr., U. S. Engr. Office (Res., 1635 Thirty-Sixth St.), Rock Island, Ill.

SCHLUBACH, HENRY LESLIE (Assoc.M '38), 43 Prospect St., Larchmont, N.Y.

SHOEMAKER, SYDNEY ARTHUR (Assoc. M. '38), Traffic Analysis Engr., Blanket Count Supervisor and Draftsman, State Highway Dept., Austin (Res., 606 Prairie Ave., Cleburne), Tex.

SMITH, FRED GEHRMANN (Jun. '37), Care, Lago Petroleum Corporation, Apartado 172, Maracaibo, Venezuela.

SMITH, JOHN GORDON (Jun. '38), Armour Inst. of Technology, Chicago, Ill.

SMITH, LEON ALBERT (M. '38), Supt., Water Dept., City Hall, Madison, Wis.

SPORN, PHILIP (M. '38), Vice-Pres. in Chg. of Eng., Am. Gas & Elec. Service Corporation, 30 Church St., New York (Res., 157 Beaumont St., Manhattan Beach, Brooklyn), N.Y.

STOUT, THURMAN ALLEN (Assoc. M. '37), Care, West Penn Water Co., 106 South McDonald St., McDonald, Pa.

STRIBLING, RALPH COPELAND (Assoc. M. '38), Dist. Engr., Gulf Oil Corporation, Box 938, Kilgore, Tex.

TANASSY, LOUIS (Jun. '37), U. S. Naval Reserve Aviation Base, Floyd Bennett Field, Brooklyn, N.Y.

THORSON, ROBERT HENRY (Jun. '37), 259 Ave. E, Bayonne, N.J.

TURRENTINE, ROBERT EMMETT, JR. (Assoc. M. '38), Eng. Contr., 823 M. & M. Bldg., Houston, Tex.

TYLER, FRANCIS CHAPLIN (Jun. '37), Rodman, Met. Water Bureau, Hartford, Conn.

VALLIS, JOHN NICHOLAS (Jun. '37), Asst. Dist. Engr., The Foundation Co. (Res., 53 Parnithos St.), Athens, Greece.

VAN ANTWERP, FREDERICK (Assoc. M. '38), Engr. and Supt., Parker-Schram Co. (Res., 4815 North East Alameda), Portland, Ore.

VARELA, ANTHONY ALOYSIUS (Jun. '37), 112 West Clinton Ave., Tenafly, N.J.

WILDMAN, ROBERT APRILL (Jun. '37), Insp., Underwriter's Assoc. of District of Columbia (Res., 1329 Fairmont St., N.W.), Washington, D.C.

TOTAL MEMBERSHIP AS OF JUNE 9, 1938	
Members	5,655
Associate Members	6,249
Corporate Members	11,904
Honorary Members	24
Juniors	3,739
Affiliates	78
Fellows	1
Total	15,746

WILLETT, ALBERT BERTRAM (Assoc. M. '37), Asst. Designing Engr., State Bridge Dept. (Res., 2628 Seventeenth St.), Sacramento, Calif.

WILLIAMS, CLYDE ELMER (Assoc. M. '38), Engr., Bureau of San. Eng., State Board of Health, Indianapolis (Res., 520 South East St., Plainfield), Ind.

WILLIAMS, WALTER BELFORD (Jun. '37), Asst. Res. Engr., State Highway Dept., 2213 St. John, Greenville, Tex.

WITHYCOMBE, EARL (Assoc. M. '38), Asst. Constr. Engr., State Div. of Highways, Sacramento, Calif.

WOODRUFF, RICHARD SHAUL (Jun. '37), 1230 South 20th St., Birmingham, Ala.

YOUNG, SAMUEL RICHARD (Jun. '38), Field Engr., Tennessee Coal Iron & R.R. Co., 306 Forty-Second St., Fairfield, Ala.

MEMBERSHIP TRANSFERS

BALDWIN, ORVAL JAMES (Jun. '29; Assoc. M. '38), State Planning Engr., State Planning Board; Asst. Prof., Civ. Eng., Univ. of Iowa, 205 Eng. Hall, Univ. of Iowa, Iowa City, Iowa.

BUELL, ELMER ELLIOTT (Jun. '30; Assoc. M. '38), Asst. Highway Engr., U. S. Bureau of Public Roads, 2d Floor, Masonic Temple, Omaha, Nebr.

CARNAHAN, CHARLES TRUNNELL (Jun. '27; Assoc. M. '38), Associate Public Health Engr., U. S. Public Health Service, Box 1226, Miami, Fla.

CHAPTON, HERBERT JOSEPH (Jun. '36; Assoc. M. '38), Office Engr., Mono Basin Project, Dept. of Water and Power, City of Los Angeles, 207 South Broadway, Los Angeles, Calif.

CLEARY, JOHN BELFORD (Jun. '19; Assoc. M. '21; M. '38), Gen. Mgr., Am. Aggregate Co., 715 National Fidelity Life Bldg. (Res., 307 North Van Brunt Boulevard), Kansas City, Mo.

COPELAND, GEORGE ROGERS (Jun. '27; Assoc. M. '38), Asst. Director, State Planning Board, 928 North 3d St. (Res., 3411 Montour St., Paxtang), Harrisburg, Pa.

CULVER, LEWIS MATSON (Jun. '26; Assoc. M. '38), Asst. Engr., U. S. Bureau of Reclamation, U. S. Customs House (Res., 1168 South Gilpin St.), Denver, Colo.

DAVIDSON, ROSCOE ALEXANDER (Jun. '28; Assoc. M. '38), Constr. Engr. and Supt., Porterfield-Binger Constr. Co., Youngstown, Ohio.

DICK, ALBERT (Jun. '21; Assoc. M. '29; M. '38), Asst. Engr., Div. of Design, Borough Pres. of Manhattan, Room 2190, Municipal Bldg. (Res., 2775 Morris Ave.), New York, N.Y.

ELLABY, CHARLES HAMILTON (Assoc. M. '29; M. '38), Senior Engr., U. S. Engr. Dept., 819 U. S. Courthouse and Customhouse, St. Louis, Mo.

ERTHAL, KARL EMIL (Jun. '31; Assoc. M. '38), Asst. Engr., Whitman, Requardt & Smith, West Biddle St. at Charles (Res., 1218 St. Paul St.), Baltimore, Md.

FLAGG, JAMES DONALD (Jun. '29; Assoc. M. '38), Asst. Engr., TVA (Res., Whittle Springs Hotel), Knoxville, Tenn.

GOTAAS, HAROLD BENNEDICT (Jun. '30; Assoc. M. '38), Asst. Prof., San. Eng., Public Health School, Univ. of North Carolina, Chapel Hill, N.C.

HAMMELEF, PETER CHRISTENSEN (Assoc. M. '25; M. '38), Associate Highway Engr., U. S. Bureau of Public Roads, Masonic Temple Bldg., Omaha, Nebr.

HAMMOND, HAROLD FRANCIS (Jun. '31; Assoc. M. '38), Director, Traffic Div., National Conservation Bureau, 60 John St., New York, N.Y.

HINCKLEY, HORACE PARKER (Jun. '31; Assoc. M. '38), Engr., San Bernardino Val. Water Conservation Dist., 1011 North University St., Redlands, Calif.

JEWETT, JOSEPH EUGENE (Assoc. M. '29; M. '38), Senior Engr. in Chg., Lands Section, U. S. Engr. Office, Clock Tower (Res., 1619 Thirty-Sixth St.), Rock Island, Ill.

KOMORA, ANDREW MITCHELL (Assoc. M. '35; M. '38), Acting Constr. Engr., TVA, Box 396, Norris, Tenn.

LEONARD, JOHN JOSEPH (Jun. '34; Assoc. M. '38), 1621 Dewing Way, Walnut Creek, Calif.

LIPP, MORRIS NATHAN (Assoc. M. '28; M. '38), City Engr., City Hall, Miami Beach, Fla.

MADDOX, EDWARD FINNIN (Assoc. M. '33; M. '38), Res. Engr., State Highway Dept. (Res., 4129½ University Boulevard), Dallas, Tex.

NELSON, FRANK KJELD (Jun. '29; Assoc. M. '38), Senior Draftsman, State Highway Dept., 212

Main St. (Res., 539 Deer Park Ave.), Babylon, N.Y.

ORSELLI, ALFRED JOSEPH (Jun. '27; Assoc. M. '38), Constr. Engr., Bechtel & McCone Corporation, 1561 Arch St., Berkeley, Calif.

OWENS, TERRENCE JOSEPH (Jun. '29; Assoc. M. '38), Zone Supervisor, WPA, City Hall (Res., 1246 Claremont St.), Pueblo, Colo.

PAUSTIAN, RAYMOND GEORGE (Jun. '29; Assoc. M. '38), Asst. Prof., Civ. Eng., Iowa State Coll., Ames, Iowa.

PERSON, HJALMAR THORVAL (Jun. '26; Assoc. M. '31; M. '38), Cons. Engr.; Prof. and Head, Civ. Eng. Dept., Univ. of Wyoming, Laramie, Wyo.

PHILLIPS, CUSHING (Assoc. M. '24; M. '38), Lt.-Commander, C.E.C., U.S.N., Public Works Officer, U. S. Naval Station, Guantanamo Bay, Cuba.

PROTHEROE, MAURICE RAYMOND (Jun. '26; Assoc. M. '37), Asst. Engr., U. S. Engr. Dept., U. S. Engr. Office, Jacksonville, Fla.

PURCELL, WILLIAM STANLEY (Jun. '30; Assoc. M. '38), Senior Valuation Engr., Public Service Comm., 80 Centre St. (Res., 1678 First Ave.), New York, N.Y.

ROOT, ISMAR EARL (Jun. '35; Assoc. M. '37), Associate Progress Engr., FSA, 912 Bell Bldg., Montgomery, Ala.

ROTHSCHILD, ROBERT BARNET, JR. (Jun. '29; Assoc. M. '38), Engr., MacDonald & Kahn Co., Ltd., Financial Center Bldg. (Res., 3045 Jackson St., Apartment 401), San Francisco, Calif.

SERVER, JOHN MARKLEY, JR. (Jun. '28; Assoc. M. '38), Senior Draftsman, Los Angeles County Flood Control Dist., 751 South Figueroa St., Room 416, Los Angeles (Res., 114 West Eulalia St., Glendale), Calif.

WOODRING, PHILIP WENDELL (Jun. '29; Assoc. M. '38), Junior Materials Engr., State Highway Dept., Testing Laboratory, 1118 State St. (Res., 2572 Lexington St.), Harrisburg, Pa.

REINSTATEMENTS

BICKEL, JOHN OTTO, Assoc. M., reinstated May 16, 1938.

BRONSON, JOSEPH CHANDLER, Assoc. M., reinstated May 12, 1938.

GOODENOUGH, BERTRAM WILLIS, Assoc. M., reinstated May 26, 1938.

HELLER, JOHN CHARLES, Assoc. M., reinstated June 4, 1938.

JOHNSON, JOHN DANIEL, Assoc. M., reinstated May 16, 1938.

SMITH, RICHARD BENNETT, Assoc. M., reinstated April 11, 1938.

SYKES, ROY JAMES, Jun., reinstated May 20, 1938.

RESIGNATIONS

ERLANDSEN, OSCAR, JR., Jun., resigned May 25, 1938.

GILCREAST, FRANK WEBSTER, M., resigned June 6, 1938.

GOCHNAUER, HARRY WALLIS, Assoc. M., resigned May 18, 1938.

HALL, BENJAMIN MORTIMER, JR., M., resigned June 6, 1938.

KEHOE, EDWARD JAMES, Jun., resigned June 6, 1938.

LAYNE, ARTHUR ROBERT, Jun., resigned May 23, 1938.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

July 1, 1938 NUMBER 7

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

MEMBER

BURKE, GEORGE LEO, West Hartford, Conn. (Age 38.) Deputy Commr., Connecticut State Dept. of Public Works. Refers to H. B. Alvord, W. V. Barry, B. L. Bigwood, G. D. Clarke, C. S. Ell, A. G. Hayden, G. A. Schaefer.

CHOU, CHEN-LUN (Alias Charles Lun Chou), Canton, China. (Age 45.) Director & Engr.-in-Chf. of Canton New Water-Works Constr. Bureau, and of Pearl River Back Reach Improvement Bureau of Whampoa Port Development Administration. Refers to C. P. Hsueh, K. H. Shih, E. C. Stocker (Applies in accordance with Sec. 1, Art. I, of the By-Laws).

DONNAN, WILLIAM CHARLES, Pittsburgh, Pa. (Age 54.) Div. Supt., Distribution Div., Bureau of Water, Dept. of Public Works. Refers to S. Eckels, C. J. Eld, Jr., J. S. Lambie, M. M. Maneese, I. C. Palmer, R. S. Quick, C. M. Reppert, J. M. Rice, N. Schein, J. D. Stevenson, C. M. Vetter, W. A. Wolffe.

EUGENIDES, ERNEST KYRIACOS, Chicago, Ill. (Age 49.) Private engineering practice. Refers to L. M. Gram, J. R. Hall, H. E. Riggs, H. G. Suehrstedt, J. S. Worley.

GIBSON, WILLIAM MUREL, Jackson Heights, N.Y. (Age 36.) Chf. of Party and Sponsor Representative, Div. of Geodesy, U. S. Coast & Geodetic Survey, New York City. Refers to W. Bowie, L. O. Colbert, G. D. Cowie, C. L. Garner, H. W. Hemple, G. T. Rude.

GREULICH, GERALD GREGORY, Pittsburgh, Pa. (Age 42.) Sales Engr., Carnegie-Illinois Steel Corporation, Consultant to Engrs. and Contrs. on foundation and bridge-floor problems, etc. Refers to V. D. Beard, H. R. Blickle, H. A. Brainerd, E. E. Duff, Jr., J. E. Elliott, E. H. Heald, F. M. Masters, F. S. Merrill, L. S. Moisseiff, F. L. Plummer, T. A. Straub.

GUPPY, JOHN LECHMERE, Port-of-Spain, Trinidad, B.W.I. (Age 53.) Engr. with Chas. McEnearney & Co. Ltd. (Ford Agts.) Refers to O. L. Brodie, E. C. Buck, F. W. Gardiner, F. G. Jonah, J. O. Riddel.

MALEVICH, VLADIMIR, Pittsburgh, Pa. (Age 51.) Structural Designer, Jones & Laughlin Steel Corporation. Refers to C. G. Dunnells, F. J. Evans, S. A. Shubin, H. A. Thomas, E. B. Woodin.

O'BRIEN, WILLIAM EDWARD, Madison, Wis. (Age 49.) Chairman, Wisconsin Highway Comm. Refers to R. B. Brooks, J. L. Ferebee, J. F. Janda, R. C. Johnson, A. E. Palen.

PLUMMER, RAYMOND BENTON, Indianapolis, Ind. (Age 35.) Designing Engr., Indianapolis Water Co. Refers to H. E. Babbitt, L. B. Barker, S. A. Greeley, P. Hansen, L. Pearse, C. E. Wheeler, Jr., L. C. Whittemore.

SNOW, LOWBER DEBAUN, Houston, Tex. (Age 48.) Civ. Engr., Gulf Oil Corporation. Refers to W. A. Blakemore, C. S. Clark, J. A. Focht, G. H. Lacy, S. W. Oberg, A. A. Stiles.

WOLFE, DEWITT CLINTON, Los Angeles, Calif. (Age 39.) Branch Mgr. and Engr., Sverdrup & Parcel. Refers to G. B. Archibald, C. W. Brown, J. I. Parcel, S. M. Rudder, L. J. Sverdrup, D. R. Warren.

ASSOCIATE MEMBER

ASHTON, GEORGE CRAPSER, Elmhurst, Ill. (Age 36.) With Chicago, Burlington & Quincy R.R., Chicago, Ill., designing grade-separation bridges. Refers to F. T. Darrow, B. J. Lambert, R. E. Peck, R. Sailer, J. J. Schnebelen, W. E. Wilbur.

BROTHERS, LE ROY ARGLUS, Upper Darby, Pa. (Age 34.) Asst. Prof. of Civ. Eng., Drexel Inst. of Technology. Refers to H. L. Bowman, S. J. Leonard, O. E. R. McMullen, C. L. Mann, H. Tucker.

BURNECKE, RALPH CLAUDE, Dallas, Tex. (Age 31.) Jun. Engr., WPA, being Asst. to Superv. Engr., Administrative Field Office No. 4. Refers to A. M. Brenneke, F. W. Cawthon, O. K. Koch, J. D. Morgan, F. R. Naylor, W. J. Powell.

DAWSON, MILES MERRILL, Iowa City, Iowa. (Age 35.) Asst. Prof. of military science and tactics, State Univ. of Iowa; Capt., Corps of

Engrs., U. S. Army. Refers to E. L. Daley, F. M. Dawson, J. B. Howe, B. J. Lambert, F. T. Mavis, H. E. Wessman.

DEMOYER, ROBERT, Chester, Pa. (Age 31.) Associate Prof. of Civ. Eng., Pennsylvania Military Coll. Refers to L. M. Fraivillig, M. O. Fuller, S. B. Lilly, F. L. Martin, H. G. Payrow, W. K. Wyatt.

FARLEY, WILLIAM RUSSELL, Chicago, Ill. (Age 40.) Engr. (Expert), Federal Power Comm. Refers to J. C. Beebe, A. P. Dean, E. R. Huber, W. L. Huber, E. W. Kramer, J. H. Lawrence.

GALBRAITH, RICHARD HUGH COURTNEY, Dunedin, N.W.I., New Zealand. (Age 33.) Asst. Engr. with J. G. Alexander, City Engr. Refers to T. G. G. Beck, A. W. deR. Galbraith, A. G. Park, R. W. Parkhurst, E. C. Schnackenberg, S. G. Scoular.

GOODMAN, WALTON PERKINS, Jacksboro, Tex. (Age 34.) Res. Engr., Texas State Highway Dept. Refers to C. T. Holmes, W. O. Jones, F. E. Lovett, L. Ortolani, R. Pace, A. J. Van Dyke, M. C. Welborn.

HEIN, HERBERT MARCEL, New York City. (Age 49.) Sales Representative for various factories for water-works supplies, hydrants, valves, etc. Refers to M. E. Chamberlain, W. T. Chevalier, E. J. Costello, Jr., C. S. Gleim, W. G. Moler, W. T. Sitt.

HETHERTON, PERCIVAL, Olympia, Wash. (Age 53.) Consultant, National Resources Comm., Washington State Planning Council. Refers to C. J. Bartholet, R. F. Bessey, J. P. Hart, S. B. Morris, G. L. Parker, R. K. Tiffany, R. G. Tyler.

JOHNSON, LLOYD RUEBIN, Lubbock, Tex. (Age 31.) Res. Engr. with Dept. of Agriculture, FSC, Regional Eng. Staff, Planning Div. Refers to G. D. Clyde, H. B. Elmendorf, H. T. Field, H. R. Kepner, P. F. Rossell, G. L. Seligmann.

MCCALLUM, GORDON EVANS, Grand Rapids, Mich. (Age 32.) San. Engr., Kent County. Refers to C. M. Cade, E. D. Rich, J. R. Rumsey, E. L. Waterman, C. C. Williams.

MYERS, FRANK COLBY, Oakland, Calif. (Age 45.) Draftsman, City Eng. Dept., in charge of a Traffic Investigation and Planning Div. Refers to W. N. Frickstad, H. F. Gray, M. P. Kitchel, J. G. Marr, C. A. Reed, R. R. Ribal.

ROBINSON, WILLIAM DAVIS, Houston, Tex. (Age 32.) Res. Engr. Inspector, PWA, on school buildings, exposition and convention hall, city hall, etc. Refers to J. H. Brillhart, C. M. Davis, H. E. Elrod, O. H. Lang, R. Pace, N. Wohlfeld.

SAVIBLE, WILLIAM GLADSTONE SMITH, Chattanooga, Tenn. (Age 40.) Asst. Engr. with Bridge Design Sec., TVA. Refers to C. R. Bloxton, W. N. Downey, E. Harsch, E. Scroggie, W. S. Todd, F. W. Webster.

SMITH, WILLIAM FIELDING, Houston, Tex. (Age 32.) Designing Draftsman, City of Houston. Refers to R. P. Boyd, C. R. Haile, W. W. McClendon, C. P. Smith, F. E. Smith, A. J. Wise.

VON DER LINN, ARTHUR WILLIAM, St. Albans, N.Y. (Age 43.) Technical Representative, Wm. P. McDonald Constr. Co., Flushing, N.Y., supervising civil engineers and others. Refers to J. T. Carmichael, E. J. Carrillo, H. W. Durham, J. Fertik, J. P. Hogan, H. W. Hudson, L. B. Roberts.

WALSH, EVERETT LINCOLN, Sacramento, Calif. (Age 36.) Associate Bridge Engr., State of California. Refers to C. E. Andrew, J. Gallagher, F. J. Grumm, I. O. Jahlstrom, F. W. Panhorst, T. E. Stanton, Jr.

WHITE, JULIAN HERBERT, Brewer, Maine. (Age 35.) Asst. Engr., Bangor (Me.) Hydro-Elec. Co. Refers to C. M. Allen, C. R. Bliss, H. H. Hatch, P. F. Kruse, B. F. Snow.

JUNIOR

ADAMS, GEORGE BARTON, Bryan, Tex. (Age 22.) Refers to J. T. L. McNew, J. J. Richey.

ALTER, AMOS JOSEPH, Rensselaer, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

BAGLEY, CHARLES THOMAS, Fayetteville, Tenn. (Age 22.) Refers to H. B. Aikin, R. T. Brown, N. W. Dougherty.

BARNES, GEORGE WALLACE, JR., Bryan, Tex. (Age 22.) Refers to J. T. L. McNew, J. J. Richey.

BARNES, TED COLLINGS, Chillicothe, Mo. (Age 22.) Refers to L. E. Conrad, M. W. Furr.

BARTH, HOWARD JAMES, Versailles, Ind. (Age 26.) Refers to C. A. Ellis, R. B. Wiley.

BICKERSTAFF, RAYMOND MAYHEW, Oakland, Calif. (Age 25.) Refers to R. E. Davis, C. Derleth, Jr., B. A. Etcheverry, F. S. Foote, C. G. Hyde, B. Jameyson, C. T. Wiskocil.

BLACKBURN, KARL RICHARD, Defiance, Ohio. (Age 24.) Refers to L. H. Gardner, F. L. Gorman, A. R. Webb.

BLACKWELL, DELBER LLOYD, Rozel, Kans. (Age 22.) Refers to L. E. Conrad, F. F. Frazier, M. W. Furr, R. F. Morse, L. V. White.

BLANK, OKLA JOHN, Michigan City, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

BROWN, LINAS HUTCHINS, Riverside, Ill. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

BRYAN, E. RALPH, Paicines, Calif. (Age 27.) Refers to R. E. Davis, C. T. Wiskocil.

BUCHANAN, JAMES DWIGHT, Lafayette, Ind. (Age 27.) Refers to C. A. Ellis, R. B. Wiley.

BULLINGTON, ERNST ALBERT, Palmetto, La. (Age 22.) Refers to J. H. Bateman, N. E. Lant, L. J. Muse, B. W. Pegues, F. F. Pillet.

BUTLER, MORGAN ROBERT, JR., Waukesha, Wis. (Age 21.) Refers to F. W. Garran, W. P. Kimball.

BYRD, HENRY DOWNS, Clinton, S.C. (Age 21.) Refers to E. L. Clarke, D. D. Curtis, W. S. Lindsay.

CABANISS, JACK KNISLEY, Ft. Worth, Tex. (Age 26.) Refers to J. T. L. McNew, J. J. Richey, F. M. Smith, Jr.

CARL, CHARLES ELARD, Columbia, Mo. (Age 22.) Refers to R. B. B. Moorman, H. Rubey, H. W. Wood, Jr.

CLARK EVERETT CLEVELAND, JR., Devers, Tex. (Age 21.) Refers to J. T. L. McNew, J. J. Richey.

COGGESHALL, JONATHAN WRIGHT, Pleasantville, N.Y. (Age 23.) Refers to F. W. Garran, W. P. Kimball.

COLEMAN, PAUL HENDERSON, Bonham, Tex. (Age 21.) Refers to J. T. L. McNew, J. J. Richey.

CORNELL, HOLLY ADAMS, Portland, Oregon. (Age 24.) Refers to J. R. Griffith, G. W. Holcomb, F. Merryfield, C. A. Mockmore.

CORTELYOU, FRANK MORGAN, JR., Kansas City, Mo. (Age 22.) Refers to J. L. Harrington, R. B. B. Moorman, H. Rubey.

CREACY, THOMAS NELSON, Mason City, Wash. (Age 30.) With Consolidated Bldrs., Inc. Refers to A. Bauer, A. Donaldson, J. R. Griffith, E. F. Kaiser, F. Merryfield, C. A. Mockmore, A. R. Nieman.

CROW, STEVEN GLENBURN, San Jose, Calif. (Age 25.) Refers to B. Jameyson, C. T. Wiskocil.

CURINGTON, HENRY WISDOM, Stamford, Tex. (Age 21.) Refers to J. T. L. McNew, J. J. Richey; E. W. Steel.

DAWSON, ARCHIBALD, Jefferson City, Mo. (Age 23.) Refers to R. B. B. Moorman, H. Rubey.

DERSHIMER, JOHN EDWARD, College Station, Tex. (Age 22.) Refers for J. T. L. McNew, J. J. Richey.

DEWANTE, RANDOLPH HOQUE, Hayward, Calif. (Age 20.) Refers to C. Derleth, Jr., C. G. Hyde.

EDELEN, GEORGE WATHEN, JR., Topeka, Kans. (Age 26.) Asst. Engr., Div. of Water Resources, Kansas State Board of Agriculture. Refers to L. E. Conrad, G. S. Knapp, J. B. Spiegel.

EIDSON, JOHN RUSHELL, JR., Hamilton, Tex. (Age 24.) Refers to T. A. Munson, J. J. Richey, C. E. Sandstedt.

EPP, DONALD OSCAR, Toledo, Ohio. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

ERICKSON, JOHN ALBERT, JR., Chicago, Ill. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

EVANS, JOSEPH SHELTON, JR., Cincinnati, Ohio. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

FOSTER, CHARLES BRADFORD, JR., Shreveport, La. (Age 22.) Refers to J. T. L. McNew, T. A. Munson, J. J. Richey.

GINSBERG, SAMUEL, Parksville, N.Y. (Age 26.) Refers to G. J. Davis, Jr., D. C. A. du Plantier.

GOOD, EDWARD ALBIN, Leesburg, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

GRAHAM, CAMERON ELLIOTT, Indianapolis, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

GRASSO, WARREN ALWIN, San Antonio, Tex. (Age 20.) Refers to J. T. L. McNew, J. J. Richey.

GREEN, ARTHUR HENRY, Oakland, Calif. (Age 23.) Refers to F. S. Foote, C. T. Wiskocil.

GREENWOOD, HAROLD FRANCIS, Oxford, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

HALL, RICHARD ENDICOTT, Berkeley, Calif. (Age 20.) Refers to F. S. Foote, C. T. Wiskocil.

HARRIS, GLEN HUGH, Beeville, Tex. (Age 23.) Refers to J. T. L. McNew, J. J. Richey.

HESSLER, ULRICH SCHNEIDER, St. Joseph, Mo. (Age 21.) Refers to R. B. B. Moorman, H. Rubey.

HIGHTOWER, CHARLES LEE, JR., Tigerville, S.C. (Age 23.) Refers to J. Anderson, J. E. Sirrine.

HILL, HENRY FORREST, Newark, N.J. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

HOLBROOK, WALLACE, Los Angeles, Calif. (Age 26.) Refers to C. Derleth, Jr., C. G. Hyde, B. Jameyson, G. E. Troxell, C. T. Wiskocil.

HOLT, JOSEPH FRANCIS, New York City. (Age 28.) Refers to J. R. Cook, C. M. Everett, N. L. Hammond, F. H. Hapgood, A. P. Loriot, M. Pirnie.

IVERSEN, LLOYD, Berkeley, Calif. (Age 23.) Refers to C. Derleth, Jr., C. T. Wiskocil.

JACOBSON, RANDOLPH NORMAN, Evanston, Ill. (Age 21.) Refers to A. S. Hathaway, G. A. Maney.

JARED, JOHN BALLARD, JR., Houston, Tex. (Age 24.) Instrumentman, American Petroleum Company. Refers to S. J. Bell, J. H. Bringhurst, E. H. Elder, L. B. Ryon, Jr., L. V. Uhrig, W. E. White.

KIMMEL, RAYMOND MALCOLM, Lawrenceville, Ill. (Age 23.) Refers to C. A. Ellis, R. B. Wiley.

KING, CARROLL AUSTIN, JR., Stephenville, Tex. (Age 21.) Refers to J. T. L. McNew, J. J. Richey.

KOMLINE, THOMAS RAYMOND, Dunellen, N.J. (Age 26.) Asst. Engr., Joint Sewage-Disposal Plant, Plainfield, N.J. Refers to E. S. Chase, H. N. Lendall.

LAMONT, CHARLES MALLOY, Raeford, N.C. (Age 22.) Refers to J. Anderson, L. S. Le Tellier.

LANE, LAWRENCE ALVA, Berkeley, Calif. (Age 23.) Refers to F. S. Foote, C. T. Wiskocil.

LARUE, GEORGE EDGAR, Columbia, Mo. (Age 24.) Refers to R. B. B. Moorman, H. Rubey, H. W. Wood, Jr.

LEAVER, ROBERT EDMUND, Reno, Nev. (Age 20.) Refers to F. L. Bixby, H. P. Boardman, C. L. Hill.

LEE, JAMES FOOK LAM, Hempstead, N.Y. (Age 23.) Refers to C. A. Ellis, R. B. Wiley.

LETSINGER, CLARENCE AUSTIN, Jasonville, Ind. (Age 29.) Refers to C. A. Ellis, R. B. Wiley.

LONG, MALCOLM M., McKinney, Tex. (Age 23.) Refers to J. T. L. McNew, J. J. Richey.

LOWRANCE, FRANK EMANUEL, Oxford, Miss. (Age 27.) Asst. Project Engr., Mississippi State Highway Dept. Refers to C. E. Downing, A. B. Hargis, R. B. B. Moorman.

MCCORMICK, CHARLES WASHBURN BRERETON, Los Angeles, Calif. (Age 22.) Refers to C. Derleth, Jr., F. S. Foote.

MCFADDEN, DAMON HALFORD, Bedford, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

MCLEROY, JOHN OTTO, Alvarado, Tex. (Age 22.) Refers to J. T. L. McNew, J. J. Richey.

MANN, DAVID MORTON, City Mills, Mass. (Age 22.) Refers to F. W. Garram, W. P. Kimball.

MARSHALL, DONALD GEORGE, St. Joseph, Mo. (Age 22.) Refers to R. B. B. Moorman, H. Rubey, H. W. Wood, Jr.

MEYER, JOHN HAROLD, Rocheport, Mo. (Age 22.) Engr. with Deering & Clark, Archts., Columbia, Mo. Refers to R. B. B. Moorman, H. Rubey, H. W. Wood, Jr.

MILLIRON, WILLIAM RALPH, West Los Angeles, Calif. (Age 25.) Jun. Eng. Draftsman and Asst. Inspector on construction, Berkeley (Calif.) Board of Education. Refers to T. F. Chace, C. T. Wiskocil.

MOORE, HENRY SPERRY, Tucson, Ariz. (Age 25.) Draftsman, City of Tucson, on plans for street-paving projects. Refers to E. S. Borgquist, E. H. Burroughs, Jr., F. R. Harris, F. C. Kelton, L. A. Robb, R. N. Spooner.

MORRIS, LORENZO EUGENE, Tolar, Tex. (Age 27.) Refers to J. T. L. McNew, J. J. Richey.

MURPHY, FRANCIS C., Berkeley, Calif. (Age 23.) Refers to C. Derleth, Jr., S. T. Harding, C. G. Hyde, B. Jameyson, F. C. Scobey, C. T. Wiskocil.